PROMOTING WRITING ACHIEVEMENT THROUGH DIGITAL CLOUD-BASED WRITING INSTRUCTION

by
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Abstract

Research has shown that low-income and minority students experience both achievement gaps (Pitre, 2014) and digital divides (Attewell, 2001). There is evidence of a relationship between computer usage and positive educational outcomes across content areas (Casey, Layte, Lyons, & Silles, 2012; Fairlie & London, 2012), which may leave students without sufficient experiences using technology in schools at a disadvantage in an increasingly digital world. Data from the 2011 National Assessment of Educational Progress (NAEP) eighth grade computer-based writing assessment showed writing achievement gaps on a computer-based assessment, which suggests a need for interventions designed to improve digital literacy skills for low-income and minority students to promote college and career readiness. A review of the literature was conducted to inform an intervention to address this problem through the lens of Experiential Learning Theory (Kolb, 1984). An intervention was conducted to incorporate Google docs and Typing Agent as instructional tools during writing instruction in fourth and fifth grade classrooms. Writing and typing achievement, along with student perceptions of and experiences with digitally-based writing, were measured to assess the effectiveness of this intervention in addressing writing achievement gaps on computer-based writing assessments. The findings indicated that student experiences with digitally-based writing were primarily positive, and that the intervention had a positive effect on student writing achievement as measured by digitally-based assessments.

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Dedication

This dissertation is dedicated to Devin Zibulsky for all of his love, support, and understanding over the years.

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Chapter 1

Problem of Practice Literature Review

Many people use digital technology in their daily lives. The prevalence of digital technology can be seen when cooking, cleaning, commuting, and computing. As digital technology becomes an active and central part of life, possessing a set of digital literacy skills is essential. Students who lack access to or experience with digital technology at home and school may be unable to compete in this new digitally-based world. Some students, particularly students of color and students from low-income backgrounds, may lack the experience to express themselves in digital environments as a result of societal inequality. Differences in teacher comfort and ability to integrate digital technology into their classrooms may also contribute to this problem (Lemon & Garvis, 2016). The difficulty faced by teachers in incorporating digital technology into their instruction may contribute to the challenge students experience in expressing themselves in digital environments.

The ability to express content knowledge in class, on standardized assessments, and in future careers requires students to possess a specific set of digital literacy skills. Data from standardized assessments, grade-point averages, and graduation rates has demonstrated an ongoing achievement gap that affects low-income and minority students (Pitre, 2014). These same student groups have been shown to be subject to a digital divide, in which their access and usage of digital technology is low when compared to their more affluent peers (Attewell, 2001). These digital divides and achievement gaps are particularly relevant to Washington, DC students because the city adopted the PARCC assessment, which is computer-based. DC students who are subject to these

digital divides may lack content knowledge, or they may lack the digital skills to demonstrate that content knowledge in a digital environment, exacerbating achievement gaps on computer-based standardized assessments.

This dissertation explores digital literacy skills specific to computer-based writing instruction to better understand digital divides and achievement gaps on computer-based writing assessments. This chapter reviews the literature related to achievement gaps and the digital divide to better understand how to prepare digitally literate students with the skills needed for academic writing in the 21st century. After introducing the concept of digital literacy and the role of computers in education, this chapter examines modern standardized assessments. The focus then shifts to evidence of a digital divide along socio-economic and racial lines and the research that has been conducted to study this problem. This chapter then explores how the digital divide may contribute to achievement gaps because writing content knowledge has become inseparable from the digital tools on which writing takes place, particularly as assessments have become computer-based. This chapter then concludes with a discussion of the relationship between computer access, usage, and a variety of achievement measures.

Digital Literacy and Computers in Educational Practices

Technology in its many forms has always played a central role in education (Cox, 2013). Educators have needed to identify the digital literacy skills required to adapt to technological change and prepare a future generation of learners for success in college and their careers (Mckee-Waddell, 2015). The Common Core College and Career Readiness Standards for Writing included standards related to the ability to produce and publish writing using digital technology (College and Career Readiness Anchor

Standards for Writing, 2018). These skills were identified as standards to ensure students were prepared for college or career upon high-school graduation.

The digital writing skills defined as necessary for college and career readiness have been measured through digitally-based assessment to reflect the importance of digital environments today (McKee-Waddell, 2015). Digital literacy has been defined as the engagement in literacy practices that use an electronic format (Chase & Laufenberg, 2011) and as the skills needed to use a set of digital tools (Jones & Hafner, 2012). Using these definitions, the term digital literacy can be applied to reading and writing that uses any form of digital technology. Technology can be defined as any equipment or system that assists people in their daily lives (Hallström, Hultén, & Lövheim, 2014). Because technological tools change rapidly, it is helpful to define digital literacy as it applies to a specific tool and the skills needed to use it.

Computers are the most relevant form of digital technology to this dissertation because they have recently been adopted for digitally-based assessments. The integration of new technology in education led to the implementation of the objective-based assessments used today (Clarke, Madous, Horne, & Ramos, 2000), and as these assessments have moved to digitally-based environments, technology and learning became even more closely connected. This inter-connectedness can make it more difficult to differentiate student content knowledge from digital literacy skills because students must use both skill sets on these digitally-based assessments.

Research on the impact of computers on educational practices began as early as the 1980s. Mehan (1989) investigated the impact of adding microcomputers to four elementary classrooms throughout a year-long observational study. The study found that

adding microcomputers to classrooms not only restructured how teachers organized instruction, but also increased communal learning opportunities through group-oriented problem-solving. The dual impact of computers on learning practices exemplified the potential benefits presented by classroom computers, but also demonstrated the need for teachers and students to possess multiple skill sets in order to integrate computers effectively.

In the 30 years after the Mehan (1989) study, the increasing prevalence of digital technology in schools and in the workplace has made digital literacy skills even more relevant. Mehan's (1989) findings aligned with Bhatt and colleagues' (2015) idea that technology and digital media had the power to change the structure of an environment. Digitally-based writing assessments have restructured testing environments by introducing computers as a tool to measure student writing ability. Computer-based assessments may reflect inequity because low-income students who lack access to computers may not have an equal opportunity to practice expressing content knowledge on a computer.

To develop the skills required for college and to prepare for many different careers, students must have access to computers and experience using them for writing. Schools have an opportunity to develop these digital literacy skills. While there are many types of digital literacies needed for college and career, this paper focuses on digital literacy within computer-based writing. The next section addresses the role of computer-based assessment and the specific digital literacy skills needed for success in a computer-based testing environment.

Digital literacy skills and computer-based standardized assessments.

Life in the 21st century demands increasing digital competencies, and education must keep pace. According to the National School Boards Association, one of the main goals of public education is to provide equal opportunity and access to a high-quality education (Peifer, 2014). In April 2011, The Educational Testing Service (ETS) established The Gordon Commission, a panel of 30 education experts. The commission's report aimed to reform standardized assessments in the United States so that the assessments would reflect the integration of technology into teaching and learning (Haertel, 2014; Kaestle, 2014). Following the initial report, Baker and Gordon (2014) worked with this panel of education experts over a two-year period to investigate the changing role of assessment. The panel determined that future assessment should be used as a tool to inform instructional practices rather than as an accountability measure. To accomplish this goal, the panel recommended that assessment move to a digitally-based format to reflect instructional practices and the demands of a 21st century economy (Baker & Gordon, 2014; Haertel, 2014).

Addison and McGee (2015) expressed agreement that standardized assessments needed to shift away from measures of accountability and become instructional tools that prepared students with the skills needed to be proficient college-level writers. Beyond college readiness, employers have also expressed the value of a digitally literate workforce (Raish & Rimland, 2016). Preparation for computer-based assessments should not be the primary goal for teaching digital literacy skills because these skills are necessary to succeed as a writer, in many professions, and throughout daily life.

While it may be difficult for digitally-based writing assessments to separate student writing ability from digital literacy skills, digitally-based writing assessment is a useful tool because it reflects the digitally-based writing skills that students need for college and career readiness. To successfully assess students in a digital format, teachers need their own digital literacy and classroom management skills (Eyal, 2012) and positive attitudes toward technology (Drossel, Eickelmann, & Gerick, 2017). If students do not use computers in their classrooms, and if teachers do not have the skills to teach using digital environments, then students may not develop the digital literacy skills they need for college and employment. In order to give students equal opportunity of educational and career options and achieve the goal of public education, students must first be given the opportunity to obtain a fundamental level of digital proficiency.

Equipping students with digital literacy skills has been shown to require transformed pedagogical practices and the implementation of digital tools in writing classrooms (Hutchison & Colwell, 2014; Mckee-Waddell, 2015). While this work within the classroom was shown to improve students' digital literacy skills, students who also had opportunities to develop digital literacy at home may have an advantage compared to those who do not. Low-income students without computers at home do not have the same opportunity to apply and practice the digital literacy skills taught at school. This may impede their ability to express content knowledge in computer-based writing, resulting in a digital divide.

The Digital Divide

Attewell (2001) identified two digital divides between students who have and those who lack computers: access and use. Student "access" was defined as the

availability of a working computer and "use" as how the computer was used by the student. While more recent research has tried to refine this definition with the concept of digital inclusion (Dean, 2015), this paper will use Attewell's definition as a framework because it has been supported by a large body of student achievement literature. Attewell's research found that about 19% of low-income students did not have access to a computer at home. Despite these findings, Attewell expressed optimism that falling technology prices would bridge the gap in the future.

More recent data has demonstrated that this gap persists. In 2015, 24% of fourth grade public school students who were eligible for free and reduced price lunch did not have a computer at home, while only 8% of non-eligible students did not have a computer at home, based on the National Assessment of Educational Progress (NAEP, U.S. Department of Education, 2015). These data demonstrated the existence of a digital divide and that socio-economic status was a key factor. NAEP data also showed that 55% of 4th grade public school students were eligible for free or reduced-price lunch, which was an increase from 41% in 1998 (U.S. Department of Education, 2015). With a growing population of low-income students in the United States, it is important to consider how the digital divide impacts student achievement now that standardized assessments are computer-based.

While the digital divide can be explained in terms of socio-economic status, specifically that financial resources are needed to gain access to and experience with digital technology, the digital divide that exists along race/ethnic lines can be defined in terms of cumulative discrimination (National Research Council, 2004). Racial discrimination is a cumulative process that occurs systematically over time and across a

number of different domains (e.g., finance and education). The digital divide that exists between racial/ethnic groups cannot be completely understood in terms of a single episode of discrimination directed towards students who are currently attending schools, but rather by understanding that racial discrimination is transmitted by institutions and social structures over generations. It may be more difficult for students of color to obtain equitable access and opportunities to use digital technology because of the cumulative social and financial consequences of racial discrimination from previous generations, leading to the current digital divide.

The digital divide exists between both socio-economic and racial groups in the form of computer access, and as a second digital divide based on computer usage (Attewell, 2001; Harris, Straker, & Pollock, 2017). The different ways in which students use computers may have influenced their development of digital literacy skills (Mckee-Waddell, 2015; Meyers, Erickson, & Small, 2013). Internet usage was found to be divided along socio-economic lines, where poor families were less likely to have access than their middle class and high-income peers (Deursen & Dijk, 2014; Howard, Busch, & Sheets, 2010; Natriello, 2001), which suggests that the digital divide is associated with educational differences between classes (Wei, 2011). Understanding the impact of the digital divides of access and usage is useful in promoting equitable educational outcomes as computers become a more prolific tool for education and assessment. Students who lack sufficient resources may lack access and opportunities to use computers, which may cause this divide to widen.

As the prevalence of digital technology has increased in society as a whole, one might conclude that these digital literacy gaps may close over time. However, research

has found that growth in information communication technologies (ICT) in a country as a whole did not lead directly to a more digitally literate population of students, and that the digital divide continued to exist along socio-economic lines (Deursen & Dijk, 2019; Zhong, 2011). These findings indicated that, even when most students had access to computers, some students were left behind because they did not all use technology in ways that promoted learning.

This divide has been found in the United States, even as computers become a closely integrated learning and assessment tool. Wood and Howley (2012) surveyed a representative sample of Ohio elementary school teachers to better understand the presence of the digital divide in schools. They found that more affluent students demonstrated a more comprehensive set of digital literacy skills than their less affluent peers (Wood & Howley, 2012). These findings suggest that gaps continue to exist along socio-economic lines despite the mastery of basic technological skills, which may indicate that even with the prevalence of technology, socio-economically disadvantaged students were still being left behind. Simply integrating computers into the home was not enough to help low-income families overcome these digital divides (Snyder, Angus, & Sutherland, 2002) because usage also mattered.

A study by Ritzhaupt, Liu, and Dawson (2013) further supported this idea that computer usage impacted digital literacy. Using a sample of 5,990 Florida middle school students, this study assessed five components of information communication literacy using a performance-based assessment administered in a technology-based environment. The findings of this study supported the existence of digital literacy gaps along socio-economic lines. The study also found that middle school students generally struggled to

demonstrate knowledge using information communication technologies, despite the increased usage of these technologies in schools (Ritzhaupt, Liu, & Dawson, 2013). These findings support the idea that the digital divide for low-income students continues to exist despite the increased usage of computers in schools, which indicates that these computers may not have been integrated effectively.

Even with the high rate of adult digital proficiency of 83.7% from one international survey (Dean, 2015), research has supported the existence of digital divides along socio-economic lines. The problem of bridging the digital divide is not unique to the United States. Other countries have enacted policies and conducted research that aimed help to understand and address this gap in the United States.

Global research on the digital divide.

Studies from around the globe have examined the effects of programs that provide home computer access in order to better understand the digital divide (Deursen & Dijk, 2019; Harris, Straker, & Pollock, 2017; Jewitt & Parashar, 2011; Malamud & Pop-Eleches, 2011; Pittaluga & Rivoir, 2012; Starkey & Zhong, 2019). As discussed previously, access to computers alone does not automatically lead to a digitally literate populace, but it is a necessary first step in moving towards digital inclusion (Attewell, 2001; Dean, 2015). These studies inform the problem of equity in computer-based standardized assessment because they examine the relationship between home computer access and usage on a variety of outcomes.

Internationally, government programs have been used to facilitate home computer access in an effort to bridge the digital divide. In Romania, vouchers have been used to provide home computer access for low-income families. A study of this initiative found

that introducing a computer into the home led to improved computer and cognitive skills, especially when accompanied by parental involvement (Malamud & Pop-Eleches, 2011). The observed evidence of improvement in computer and cognitive skills demonstrated the value of home access as a first step in developing digital literacy for computer-based assessments.

A U.K. study used a similar intervention called the Home Pilot Programme that provided computers to low-income families (Jewitt & Parashar, 2011). Jewitt and Parashar (2011) aimed to measure the effects of home computer ownership and internet access on students between the ages of five and nineteen through student and teacher surveys. They found that having a computer in the home resulted in more time using a computer for academic activities, such as homework, and that parental involvement in student academics may have increased when a computer is added to the home. This may have had positive social benefits for the family (Jewitt & Parashar, 2011). This study added to the findings of Malamud and Pop-Eleches (2011) that, in addition to changing the social environment, home computer access may have improved cognition and computer skill.

An evaluation of an initiative that provided laptops to low-income families in Uruguay called Plan CEIBAL used nationally representative survey data to conclude that the addition of a computer in the home had other positive effects on households, including more positive attitudes toward technology (Pittaluga & Rivoir, 2012). Findings from these three interventions regarding home computer access supported the positive impact of home computer access in bridging digital divides.

Another study, which concluded that computer access alone did not impact achievement, was conducted by Starkey and Zhong (2019). They examined the effect of netbook use "for learning" over a two year period on mathematics, reading, and writing achievement. The results showed that netbook use was not a significant predictor of achievement, but that demographic factors such as school and gender were significant predictors. Once again, computer access alone was not linked with positive achievement outcomes.

Harris, Staker, and Pollock (2017) studied a government initiative in Australia that aimed to close gaps in access to computers across socio-economic lines. Using a sample of 1,351 students between the ages of six and 17 years old, researchers found that computer usage differed across socio-economic lines even when gaps in access were closed. Students from higher socio-economic backgrounds reported using the computer for academic purposes and in school more often than their peers from lower socio-economic neighborhoods. These findings indicate that the way in which a computer is used may differ along socio-economic lines, which may in turn impact academic achievement.

One study identified a possible mechanism by which differences in use can occur along socio-economic lines (Deursen & Dijk, 2019). Looking at a sample from the Netherlands, a country with universally available broadband internet, the authors found that there was a socio-economic divide, based on education, employment, and family income, in the access to hardware devices and online services. These studies support the conclusion that the digital divide cannot be addressed by access to technologies or the internet alone. Evaluation of international governmental initiatives has also highlighted

important factors that may have contributed to the digital divide, such as parental involvement, attitudes toward technology, hardware costs, and using devices for academic purposes.

Achievement Gaps and Computer Usage

The cultural and economic factors that define the digital divide also align with achievement gaps that exist on standardized assessments. Now that these standardized assessments are computer-based, these achievement gaps may be further impacted by digital literacy. Achievement gaps have been shown to exist along racial-ethnic (Vanneman, Hamilton, Baldwin Anderson, & Rahman, 2009) and socio-economic lines (Gamoran & Long, 2007; Reardon, 2011). The importance of educational equity was raised by Coleman's 1966 *Equality in Educational Opportunity* report, which found that socio-economic status had significant impacts on student achievement (Coleman et al., 1966). Over time, this finding has gained further support, highlighting the ongoing achievement gap between low and high income students (Gamoran & Long, 2007).

In attempting to address these achievement gaps, accountability movements aimed to hold schools accountable by implementing high stakes standardized assessments (Rashid & Johnson, 2011). However, research on these assessments found that instruction driven by high-stakes standardized tests led to higher scores on that particular assessment, but not to higher student achievement on other types of assessments such as the SAT, ACT, or NAEP (William, 2010). School accountability measures, such as standardized assessments, were not proven to boost student achievement as proponents had claimed (Clarke et al., 2000). These finding supported the Gordon Commission report's conclusion that, rather than serving as an accountability measure, assessment was

a necessary tool to inform pedagogy that prepares students for college and their future careers.

Now that digital standardized assessments have become more prevalent (Kaestle, 2014), it may be more difficult for assessments to differentiate student content knowledge from digital skills. Due to the existence of the digital divide, some students may be more prepared to express their content knowledge on these assessments than others. These technologies may or may not be used during content instruction, creating a disconnect between content knowledge and expression of these skills in a digital environment. Digitally-based writing as a whole, specifically demonstrating writing ability and the writing process (which includes drafting, revising, and publishing in a digital environment), is a necessary skill for college and career readiness according to the Common Core State Standards. If the goal of public education is to provide an equal opportunity for all students, then all students must be equipped with these skills. Therefore, student writing ability and digital literacy skills are jointly represented in digitally-based writing, which is reflected in the skills required for success on computer-based writing assessments. These assessments can inform pedagogy, which is reflected in how computers are used in schools.

School computer usage and student achievement.

While achievement gaps on assessments have been shown to exist along socio-economic and racial lines, schools have the power to help mitigate these gaps and act as an equalizer for low-income students (Downey, Hippel, & Broh, 2004). The integration of technology into instruction can begin to address these gaps by facilitating learning, especially for students with specific learning needs (Chen, Heritage, & Lee, 2005;

Meyen, Poggio, Seok, & Smith, 2006). This section explores research related to the relationship between school computer usage and achievement outcomes, including studies with both negative and positive findings.

Negative and inconclusive findings related to school computer usage.

Research that analyzed data from Israel's Tomorrow-98 program, a program that equipped classrooms with computers and trained teachers to integrate this technology into the classroom, found that following the introduction of computers in schools, teachers used computers more often for instruction (Angrist & Lavy, 2002). However, when testing the relationship between teacher use of technology and student grade eight math test scores, a significant negative relationship was found (Angrist & Lavy, 2002). Computer usage for instruction was measured by a single survey item that asked about the use of computer software or instructional programs and did not address the specific way that the computer was used.

Although the study used a large sample, the relevance of these results may not reflect digital writing because the study focused on a different subject area. The results used math achievement data, which may not be impacted to the same extent by digital literacy skills as writing assessments. Another drawback of this study was that the measure of computer usage was too broad to identify the specific classroom practices using computers. This study examined frequency of usage rather than type of usage. Findings like these emphasize the need for additional research to explore the specific use of computers for writing practice to gain a greater understanding of the digital divide and how to address it. These findings raise the possibility that some increases in technology

use may have negative impacts on achievement and suggest a need for more research to identify the necessary elements of successful classroom usage.

An international study looked at data from the Trends in International Mathematics and Science Study (TIMSS) to examine the impact of using a computer during instruction on student achievement (Falck, Mang, & Woessmann, 2018). The authors used regression modeling to look at the relationship between different types of computer uses reported by students who took the TIMSS assessment and TIMSS achievement scores. The authors concluded that there were positive effects on achievement for using a computer to look up information, but not for using a computer to practice skills, with an overall non-significant effect of computer usage. The effects were larger for students with high socio-economic status and primarily occurred in developed countries. These limitations reduce the generalizability of the findings because they may not apply to students in poverty or students who do not have access to digital technology. The assessment in the study also examines mathematics and science rather than writing, so the results may not apply to student writing achievement.

Another study used survey data to measure the school-reported frequency of technology usage without specifically measuring how it was used (Machin, McNally, & Silva, 2007). This study used a correlational design to explore the effects of ICT funding on British school achievement outcomes using a standardized assessment. The study found that increased ICT funding had a positive relationship with science and English scores, but not with mathematics (Machin et al., 2007). One disadvantage of this study was that it used a primarily economic perspective to evaluate the effects of ICT funding per pupil without accounting for other sociological and demographic factors or for how

that funding was utilized. Although the results were inconclusive across subject areas, they supported the idea that, while the digital divide is socio-economic, funding alone is insufficient to address the digital divide without identifying effective approaches to integrate the technology into the classroom.

Positive findings related to school computer usage.

Many studies in the United States have found that school computer access and usage were positively associated with achievement outcomes (Judge, 2005; Li, Atkins, & Stanton, 2006; Martindale, Pearson, Curda, & Pilcher, 2005). Judge (2005) found positive relationships between the achievement of African-American students and having a computer at home, a computer station in the classroom, and computer software in schools. Using Early Children Longitudinal Study – Kindergarten (ECLS-K) 1998-1999 data, the author followed 1,601 public school students from kindergarten through first grade (Judge, 2005). The results supported the conclusion that access alone is related to positive student achievement outcomes. By isolating demographic variables, this study was able to examine the socio-economic digital divide that exists within one particular racial/ethnic group. Thus, these findings shed light on both socio-economic and racial-ethnic achievement gaps and digital divides, which may contribute to the problem of equity on computer-based assessments.

Tate, Warschauer, and Abedi (2016) found an overall positive relationship between using a computer in school and writing achievement. Linking participant survey responses to scores on a nationally-representative computer-based standardized assessment, the authors found that students who reported using a computer at school had higher average writing assessment scores. Students who reported specifically using a

computer at school to draft, edit, and revise writing scored higher on average than those who did not. These data were based on a large sample from the National Assessment of Educational Progress (NAEP). However, school usage was student reported rather than directly observed, which may not reflect all of the potential ways in which a computer can be used. NAEP is also a low-stakes assessment conducted by the Department of Education, which may impact student effort because the results do not directly impact students. Data were not examined by race/ethnicity or socio-economic status.

Experimental studies at the classroom level have delved deeper into how school computer usage affected student achievement outcomes (Li, Atkins, & Stanton, 2006; Martindale, Pearson, Curda, & Pilcher, 2005). Martindale and colleagues (2005) used a controlled experimental design to evaluate the effectiveness of a specific online learning application (*FCAT Explorer*) on student reading and mathematics achievement as measured by the Florida Comprehensive Assessment Test (FCAT). The FCAT Explorer was an online module that provided interactive practice aligned to measures on FCAT assessment. The sample consisted of fourth, fifth, eighth, and tenth grade students across 24 Florida schools, and the results indicated that the *FCAT Explorer* online program resulted in statistically significant positive outcomes on FCAT reading and mathematics test scores at the elementary level (Martindale, Pearson, Curda, & Pilcher, 2005), which suggests that computer usage aligned with a specific assessment may improve achievement outcomes.

Interestingly, the achievement variable was a print-based test, which suggests that using technology for learning can have positive effects on content knowledge as well as digital literacy skills (Martindale, Pearson, Curda, & Pilcher, 2005). A strength of this

study is that it explored a specific use of technology in the classroom. However, these findings were limited because the technology-based intervention was specifically designed as practice for the outcome assessment. This focus on a specific assessment left a need for further research on whether specific classroom uses of technology not aimed at a specific assessment can lead to increased digital literacy skills and content knowledge. If computers can be used to improve both digital literacy skills and student content mastery, students in low-income schools could benefit from opportunities to engage with technology in school.

A study in the United Kingdom compared digital mathematics applications to standard mathematics instruction for four- and five-year-olds (Outhwaite, Faulder, Gulliford, & Pitchford, 2019). They found that students who used the apps over a 12-week period showed significantly greater math learning gains than students who engaged in standard math practice. These findings demonstrate the potential benefits of well-developed digital tools within the classroom environment. However, the study focused on math, with a focus on specific skills, while writing may be more difficult to break down. The study also did not examine the socio-economic status of students or their previous experience with technology, which are necessary factors when aiming to close the digital divide.

In one study, keyboarding instruction was provided in schools using a web-based application (Donica, Giroux, & Faust, 2018). Students from kindergarten through fifth grade participated in the study over the course of school year. One group of students used one particular application (Keyboarding Without Tears), while the other group used free online keyboarding instructional resources. Students in grades one through five who used

the application had significantly greater changes in typing speed and showed improved keyboarding methods compared to students who used the free application. These results indicate that among students who engage in keyboarding instruction, the particular type of instruction impacts student results. This study looked only at keyboarding skill, rather than academic achievement more broadly, though it shows the potential benefits of well-designed computer usage in the classroom.

In another study that looked at typing instruction in the classroom, students in grades four, five, and six were assigned to either a touch-typing course or a control condition (Weerdenburg, Tesselhof, & Meijden, 2019). Using a pre-test and a post-test, students were evaluated on their typing, spelling, and narrative-writing skills using a computer. The group that received the touch-typing course improved more in all three areas than the control group. These results are particularly relevant to classroom writing because they include spelling and narrative-writing skills in addition to typing skill. By gaining experience using a computer in the classroom in the form of touch-typing instruction, students were able to improve their writing ability.

While the body of literature on computer usage and student achievement includes a number of mixed results, overall there is sufficient evidence that student computer usage can have a positive impact on student achievement. The evidence indicates that the form of usage must be specific to the skill that is being learned and the digital context in which that skill will be used. Additional research is needed on the role of school computer usage for writing instruction and its impact on student writing achievement.

Home computer usage and student achievement.

In 2013, President Obama began a federal initiative to get technological devices into the classrooms of America's 49.8 million students by 2017 (Scherer, 2014) to ensure that all students would have an equal opportunity to engage with computers in the classroom. While this initiative addressed the digital divide as it existed within schools, it did not address the impact of having a computer in the home on student achievement. Home computer access has been linked to high rates of school enrollment (Fairlie, 2005), increased graduation rates, higher grade point averages, and lower rates of school suspensions and crime (Fairlie, Beltrain, & Das, 2010). Research has also found that an increase in communication through email on a home computer is positively related to multiple self-efficacy measures of low-income students (Shank & Cotten, 2014), as well as self-esteem (Attewell, Suazo-Garcia, & Battle, 2003). This evidence suggests that home computer access may have both academic and social benefits.

Mixed findings related to home computer access and usage.

Overall, studies that analyzed the relationship between home computer access, usage, and a variety of outcomes had mixed findings. While some studies have found relationships between home computer use and achievement that are negative (Lee & Wu, 2012; Vigdor, Ladd, & Martinez, 2014) or unclear (Beuermann, Cristia, Cueto, Malamud, & Cruz-Aguayo, 2015; Cristia, et al., 2017; Fairlie & Robinson, 2013; Hunley, Evans, Delgado-Hachey, Krise, Rich, & Schell, 2005), most studies have found this relationship to be positive (Attewell & Battle, 1999; Attewell, Suazo-Garcia, & Battle, 2003; Borzekowski & Robinson, 2005; Casey, Layte, Lyons, & Silles, 2012; Fairlie & London, 2012; Fiorini, 2010; Nævdal, 2007; Ponzo, 2011; Schmitt & Wadsworth, 2006). These

mixed results suggest a need to delve deeper into the specific factors that contribute to achievement outcomes.

Vigdor and colleagues (2014) challenged the notion that having a computer in the home had positive effects on student achievement in reading and math. While they conceded that the literature overwhelmingly supported a positive relationship between having a home computer and achievement, their experimental study of fourth and fifth graders showed that this is not always the case. The study found a positive correlation across student groups if there was already a computer in the home. However, students who recently had a computer introduced into the home experienced a decrease in reading and math scores (Vigdor, Ladd, & Martinez, 2014), which suggests that how the computer is used at home may be more important than access alone, a theory which will be examined in the next section.

Positive findings related to home computer access and usage.

Fiorini (2010) found a positive relationship between home computer use and cognitive development in children using data from the Longitudinal Study of Australian Children (LSAC). This longitudinal study tracked a large representative sample across two periods of time to draw these conclusions and accounted for several demographic factors (Fiorini, 2010). The results revealed that home computer usage was associated with high levels of cognitive development.

Other studies have also found positive relationships between student achievement measures at home and in school (Judge, 2005; Li, Atkins, & Stanton, 2006; Ponzo, 2011). As in schools, data on both access and use of computers at home is essential to understanding the extent to which the digital divide and opportunity gap influence student

outcomes. Research found that using a computer for educational purposes at home had a stronger relationship with positive student achievement than ownership alone (Casey, Layte, Lyons, & Silles, 2012; Ponzo, 2011). Casey and colleagues used a longitudinal correlational study based on survey data in Ireland to find a positive relationship between home computer usage and achievement in reading and math measured by standardized assessments. Specifically, they found that exploring the internet for fun, using the internet for research, and sending emails were specifically associated with higher student achievement, while activities such as instant messaging and downloading music or movies had a negative impact on reading and math test scores. The findings of this study suggest that it is important to investigate more than access to a computer at home, but how that computer is used.

The relationship between home and school computer usage and student achievement has been found to be primarily positive. Now that measures of student achievement are computer-based, this relationship has become more complex because students must possess both content knowledge and digital literacy in order to be successful on digitally-based assessments. Low-income students who lack sufficient computer access and/or usage opportunities may not experience the academic benefits described in these studies or develop the computer skills to be competitive on these assessments and in life.

Conclusion

As the relevance of computers and other ICT has grown in society, the importance of digital literacy has risen as well. Digital literacy includes a complex set of skills that has been shown to be impacted by access to and usage of technological tools (Chase &

Laufenberg, 2011). Differences in access and usage of digital technology have led to a digital divide between students from high and low income backgrounds, and the need to bridge this divide has grown as technology has become an increasingly important part of teaching, learning, and assessment. The implementation of computer-based assessment and an increase in technological resources has given schools the opportunity to help mediate achievement gaps through the use of technology.

Schools serving students from low-income backgrounds with limited access to computers in the home can be better served by technology use that promotes digital literacy and supports classroom content. Existing literature has addressed this issue as it pertains to reading and math assessment. For example, Lee & Wu's (2012) research has broken down the experiences and specific skills involved in digital reading activities. These skills (e.g., scrolling) are also involved in writing assessments. Additional research is required to determine the role of specific skills on digital writing assessments. There is a significant gap in the research about the impact of digital literacy skills, such as typing, on measures of computer-based writing achievement.

Further understanding of digital literacy and its role in computer-based writing assessment is necessary to understand the variance in student writing achievement that has attributed to differences in content-knowledge as opposed to digital literacy skills. Cox (2013) highlighted the importance of targeting specific technology-based skills rather than looking at digital literacy in general because the concept of digital literacy is complex and extends beyond the scope of a classroom. With this in mind, future research is needed to target the role of specific forms of use, including typing, play in future computer-based standardized writing assessments. The following chapter examines the

relationship between home access and school computer usage on computer-based writing achievement outcomes using the 2011 grade eight National Assessment of Educational Progress (NAEP) to explore the need for intervention on these digital divides and achievement gaps.

Chapter 2

An Assessment of Need on Computer-based Writing Assessment

During the 2014-2015 academic year, DC Public Schools adopted the computer-based PARCC assessment as a yearly measure of student achievement. This change in assessment presented educators with the need to integrate technology into teaching and learning in order to prepare students for this computer-based standardized assessment. Some schools responded to this change in assessment by working towards one-to-one computer access in their classrooms, while other schools lacked the resources to do so. The integration of laptop computers as a technological tool for learning and assessment has made understanding the role of technological literacy in academic performance more important to the education community (Baker & Gordon, 2014).

Integrating technology into the learning process can restructure learning environments and practices (Baker & Gordon, 2014; Mehan, 1989) and requires a specific set of skills (Bhatt, de Roock, & Adams, 2015; Pangrazio, 2016). DC Public School teachers must use computers in the classroom to develop these skills to prepare students for computer-based PARCC assessments. However, students who have opportunities to use computers at home may have an advantage compared to students who lack access to computers or opportunities to engage in academic computer-based activities (Attewell, Suazo-Garcia, & Battle, 2003; Casey, Layte, Lyons, & Silles, 2012). This socio-economic difference reflects the existence of a digital divide between students who have access to computers at home and those who do not (Attewell, 2001).

Even before the implementation of computer-based assessments, achievement gaps existed along socio-economic and racial-ethnic lines (Coleman et al., 1966; Pitre,

2014; Vanneman, Hamilton, Baldwin, & Rahman, 2009). Disparities in access to technology fall along these same lines, which may exacerbate existing gaps when technological literacy becomes a factor in student achievement (Attewell, 2001; Becker, 2007; Dean, 2015). Addressing this digital divide is an important topic of consideration for DC Public Schools because DC schools are subject to both these existing achievement gaps and possible gaps in digital literacy.

In the 2016-2017 academic year, 86% of DC Public School students reported being students of color (Hispanic, Black, or Other) and 77% were identified as "economically disadvantaged" (District of Columbia Public Schools, 2018). Based on these proportions, the majority of the DC Public School student population is likely subject to the gaps in achievement that exist along racial and socio-economic lines. In order to serve the DC student population, a better understanding of achievement gaps across socio-economic and racial/ethnic groups is needed, and this will be explored through a needs assessment.

There was evidence in the 2017 8th grade National Assessment of Educational Progress reading data that achievement gaps in DC by race/ethnicity (60 points on a 300 point scale between White students and Black students and 58 points between White and Hispanic Students) and socio-economic status (40 points between students who were not eligible for free and reduced price lunch and those who were eligible) were significantly larger than those found in the nation as a whole (25, 19, and 24 point gaps, respectively) (U.S. Department of Education, 2017). The introduction of computer-based assessment could widen existing achievement gaps through the digital divide because digital literacy skills now play a role in content assessment. Increased computer usage at home and/or

school has been associated with positive academic achievement outcomes (Attewell & Battle, 1999; Attewell, Suazo-Garcia, & Battle, 2003; Barrow, Markman, & Rouse, 2009; Borzekowski & Robinson, 2005; Casey, Layte, Lyons, & Silles, 2012; Fiorini, 2010; Fuchs & Wossmann, 2004; Judge, 2005; Li, Atkins, & Stanton, 2006; Martindale, Pearson, Curda, & Pilcher, 2005; Nævdal, 2007; Ponzo, 2011; Schmitt & Wadsworth, 2006). However, these studies did not consider writing achievement outcomes or measures of student achievement on computer-based standardized assessments.

Prior to the needs assessment, I investigated the current state of writing achievement on computer-based assessments for low-income and minority students. An observation of two fourth grade writing classrooms in a Washington, DC Title One charter school engaging in computer-based writing activities revealed differences between students with and without home computer access. While working as a fourth grade writing teacher in 2016, I asked students whether or not they had a working computer at home and then observed these students during a writing class in which students were using Google Chromebooks to draft and revise writing.

Based on the in-class observation, low-income students who lacked access to or did not use computers at home did not show the same level of digital literacy skills during writing activities as their peers who had home access. For example, the students who lacked access showed hunched posture, slow typing speed, and visible frustration while engaging in computer-based writing activities. They showed this frustration by talking to computers, hitting their devices, or even slamming laptops closed and putting their heads down in the middle of a writing activity. Slow typing fluency, low engagement, and negative attitudes toward technology may impact those students' performance when

engaging in a timed, computer-based writing assessment. The results of this observation led to the needs assessment study described in the subsequent sections of this chapter.

Goals and Objectives

The goal of the needs assessment was to investigate the association between home and school computer usage and computer-based writing performance outcomes using a secondary data analysis of select data from the National Assessment of Educational Progress (NAEP). The needs assessment used the most recent computer-based NAEP writing achievement data from the 2011 assessment of eighth grade students across the nation. I investigated the following research questions during the needs assessment.

- To what extent do students have access to technology at home?
    - Do differences in home computer access exist between socio-economic or racial ethnic groups?
    - Are differences in home computer access associated with computer-based writing achievement within socio-economic or racial/ethnic groups?
- How do students use computers for writing in school?
    - Do differences in drafting/revising writing with a computer in class exist between socio-economic or racial/ethnic groups?
    - Are differences in drafting/revising writing with a computer in class associated with computer-based writing achievement within socio-economic or racial/ethnic groups?

Methodology

Participants.

The target population included eighth graders from across the United States who were enrolled in public schools. The sample was drawn from a nationally representative sample of over 24,000 eighth graders who participated in the 2011 National Assessment of Education Progress (NAEP) writing assessment. The sample was 51% male, 49% female, 57% White, 15% Black, 21% Hispanic, 5% Asian/pacific islander, and 2% two or more races (U.S. Department of Education, 2011). This nationally representative sample was chosen because data were not reportable for Washington, DC on this assessment, and no digital writing data were available specifically for Washington, DC. The sample may not directly reflect the demographics of Washington, DC. However, the national sample was chosen because it was a large and robust sample that can be used to explore the existence of gaps in digitally-based writing achievement. The NAEP assessment was selected over other assessment options because data was publicly available, included multiple measures of computer usage that were aligned to the research questions, and could be linked to a measure of computer-based writing achievement.

Students enrolled in DC Public Schools were 60% Black, 20% Hispanic, and 15% White, with students who identified as Hispanic being included only in the Hispanic category and no other racial category (District of Columbia Public Schools, 2018). To reflect the population of DC students, this chapter focuses on outcomes for these three subgroups. As a proxy measure used to represent socioeconomic status, 45% of the population in the NAEP sample were eligible for free or reduced lunch. The sample was compared across socio-economic and racial/ethnic subgroups to determine if differences

in home computer access and school computer usage existed between these groups. Writing achievement was then examined within these groups to determine if there were differences in writing achievement scores for students with home access and school usage versus those without home access and school usage for each group.

Measures.

The 2011 NAEP Writing Assessment was administered in schools around the country by the National Center for Education Statistics (NCES), a part of the United States Department of Education. Schools and students were selected to represent the population of students from the entire nation (U.S. Department of Education, 2017). Designated NAEP field staff from NCES went to each selected school to administer the assessment to students and the accompanying surveys to school administrators, teachers, and students. Individual students did not complete the entire assessment, but only a randomized block of items. The assessment responses for each student were then combined within a particular school, so individual students did not receive an individual score. Due to this incomplete block sampling, sample sizes were not reported for cells within the data for achievement scores or percentages based on survey responses. To protect the privacy of respondents, the NAEP Data Explorer suppressed cells that did not contain at least 62 cases or that did not draw from at least five different schools.

Survey data and assessment outcomes on the 2011 writing assessment of eighth grade public school students were examined using the NAEP Data Explorer. The NAEP Data Explorer is a free public tool that enables users to access NAEP data online. This tool allows users to select variables within a particular assessment subject, year, and geography. These data can then be used to create tables, figures, and maps. Nationally-

representative survey sampled demographic and achievement data are available at national, state, and select urban district levels. Demographic data can be examined alongside achievement data.

Using NAEP survey data, low-income status was defined as eligibility for free and reduced lunch (U.S. Department of Education, 2017). The survey also included background questions on race/ethnicity. Survey data were collected at the school level, teacher level, and student level for each school that participated in NAEP. As a result, variables in NAEP datasets were school-reported, teacher-reported, or student-reported, and they were reported as percentages within a particular geography (i.e., the nation, a particular state, or a particular urban district). Individual student data, including achievement data and survey responses, were matched to teacher- and school-based variables collected during the assessment so that student achievement was reportable for these survey variables. For example, achievement scores were reported for students whose teachers reported using computers in the classroom and could be compared against the achievement scores of students whose teachers reported not using a computer using a *t*-test to test for significance between the group differences.

Home computer access was measured by a student-reported yes or no in response to the question "Is there a computer at home that you use?" The NAEP background questionnaire contained many possible measures for school computer usage. This needs assessment focuses on the most relevant question. The first school computer usage measure was the question, asked of teachers, "How often do you ask your students to do the following when you ask them to write about something? Use a computer for drafting

and revising their writing?" This response was teacher-reported and used a four-point Likert scale.

Writing was scored on development, organization, and language facility and conventions using a six-point scale that included effective, competent, adequate, developing, marginal, and little to no skill. These scores were normed on a scale between zero and 300 with a mean of 150 (U.S. Department of Education, 2011). The measures were then analyzed across racial-ethnic and socio-economic subgroups to understand the impact of access, usage, and digital literacy skills and writing achievement within these groups. A summary of these key variables and measures can be found in Table 1.

Table 1

Construct Map: Computer-Based Writing Assessment Variables

Variables	NAEP Measure	Reported	Scale
Race/Ethnicity	Demographic Variable	School	Six options: White, Black, Hispanic, Asian/Pacific Islander, American Indian/Alaska Native, Two or more races
Socio-economic Status	National School Lunch Program Eligibility	School	Yes/no
Home Access	Is there a computer at home that you use?	Student	Yes/no
School Usage	How often do you ask your students to do the following when you ask them to write about something? Use a computer for drafting and revising their writing	Teacher	Four-point Likert scale: never or hardly ever, sometimes, very often, always or almost always
Writing Achievement	Scored on development, organization, and language facility and conventions using a six-point scale that included effective, competent, adequate, developing, marginal, and little to no skill.	Assessment Score	Scale score of 0-300

Data collection methods.

Quantitative data were examined using the NAEP Data Explorer, available on the National Center for Education Statistics website. NAEP is a congressionally authorized assessment that uses a nationally-representative sample of U.S. students. The National Assessment Governing Board, responsible for the implementation of NAEP, decided to make the writing assessment computer-based in 2011 to reflect changes in technology use. It was a timed assessment that required students to write with one of three purposes: to explain, persuade, or convey experience. Students had 30 minutes to complete two different writing tasks out of a possible 22 tasks. Before taking the test, students engaged in a tutorial that demonstrated the materials and how to use the software. NAEP provided a laptop computer to each student for the purpose of taking the assessment. The assessment has been considered a low-stakes test because it has not been used to hold schools accountable, but to investigate achievement outcomes over time (Wise & DeMars, 2005).

Data analysis.

Statistical significance testing was conducted through the NAEP Data Explorer on student achievement scores using individual t-tests. The use of *t*-tests was a limitation because it did not allow for the testing of complex relationships and created the need to conduct a large number of *t*-tests to examine each specific variable, which increased the likelihood of a family-wise error. Because the data were drawn from a large sample, there was a risk that statistically significant differences may have been found from differences that may not be meaningful in the real world (e.g., a two-point difference may be significant when looking at the national sample).

To account for the frequent use of multiple *t*-tests to test for significance in the NAEP Data Explorer, the Benjamini-Hochberg False Discovery Rate (FDR) procedure was automatically applied to these *t*-tests by the NAEP Data Explorer to adjust the alpha level based upon the number of tests being conducted to reduce the likelihood of falsely rejecting the null hypothesis (U.S. Department of Education, 2017). However, analyses conducted on different variables (e.g., home access and school usage) were treated separately by the NAEP Data Explorer, which limited the effectiveness of the FDR procedure, which was applied to each variable but not across all variables. This was a limitation because it increased the likelihood of falsely rejecting the null hypothesis based on the total number of variables included.

To address this limitation, effect size was measured using Cohen's *d* to examine the magnitude of observed differences. Cohen's *d* is computed by dividing the between-group mean difference by the pooled standard deviation. Effect sizes of 0.2 were considered small, 0.5 was considered medium, and 0.8 was considered large (Walker, 2008). The use of effect size does not reduce the risk of family-wise error, but it provides a standardized measure of the size of a particular difference.

The subsequent section reviews the needs assessment research questions using the variables provided on the 2011 NAEP eighth grade writing assessment. Descriptive statistics were provided to describe the access and use of technology at home and school, as well as across socio-economic and racial subgroups. Finally, the results included *t*-tests to determine the existence of significant differences between these variables and writing achievement outcomes across racial and socio-economic subgroups. Effect size was also reported to present the magnitude of these differences.

A limitation of this needs assessment was that data were obtained through public-release NAEP data, specifically the NAEP Data Explorer tool, rather than from raw data, which were not publicly available. Using this tool, other information, such as sample sizes and the breakdown of individual groups by additional demographic data, could not be obtained due to weighting and privacy disclosure protections.

Results

To what extent do students have access to technology at home?

This section discusses results related to home and school computer access. It then describes the differences in these variables across subgroups. Using the NAEP Data Explorer, "computer at home," "National School Lunch Program eligibility," and "Race/ethnicity used to report trends, school-reported" were selected to describe home access across these subgroups.

Do differences in home computer access exist between socio-economic or racial/ethnic groups?

In 2011, 93% of eighth grade public school students across the United States reported having home computer access. Breaking this number down based on student eligibility for the National School Lunch Program (NSLP), 88% of NSLP eligible students reported home computer access, while 97% of non-eligible students had access. This difference was significant ($p < 0.001$). When looking at access across race/ethnicity, 96% of White students, 90% of Black students, and 88% of Hispanic students had access to computers at home. Significance testing determined that there were significant differences in home computer access between racial/ethnic groups. Specifically, a higher percentage of White students reported home access to computers than Black students or

Hispanic students (p-values < 0.001), and a significantly higher percentage of Black students had home computer access compared to Hispanic students ($p = 0.004$). Differences in home access across race can be seen in Table 2.

Table 2

Differences in Home Access across Race

Comparison	Percentage 1	Percentage 2	P-values
White vs. Black	96% (White)	90% (Black)	<0.001
Standard Error	(0.3)	(0.4)	
White vs. Hispanic	96% (White)	88% (Hispanic)	<0.001
Standard Error	(0.3)	(0.6)	
Black vs. Hispanic	90% (Black)	88% (Hispanic)	0.004
Standard Error	(0.4)	(0.6)	

Are differences in home computer access associated with computer-based writing achievement within socio-economic or racial/ethnic groups?

The data on home computer access were then analyzed to see whether there was a difference in writing performance between students who had home access and those who did not. Across the nation, the average writing score for students who had access to home computers was 151, while students without computers averaged 121. This difference was significant ($p < 0.001$) and the effect size was medium (Cohen's $d = 0.52$).

The average score of 137 for NSLP eligible students with home access was significantly higher than for those without home access, whose scores averaged 118 ($p < 0.001$, Cohen's $d = 0.59$). Non-NSLP eligible students with home access averaged 162, which was significantly higher than non-NSLP eligible students without home access, whose scores averaged 133 ($p < 0.001$), and this effect was large (Cohen's $d = 0.91$). These findings indicate that the impact of home access went beyond a difference in household income.

Home access was then compared within racial/ethnic groups. White students with home access averaged 158, which was significantly higher than White students without home access, who averaged 131 ($p < 0.001$), and the effect size was medium (Cohen's $d = 0.52$). Black students with home access averaged 134, which was significantly higher than Black students without home access, who averaged 114 ($p < 0.001$, Cohen's $d = 0.63$). Hispanic students with home access averaged 138, which was significantly higher than Hispanic students without home access, who averaged 116 ($p < 0.001$, Cohen's $d = 0.67$). Across all racial/ethnic student groups, students with home access scored significantly higher on average and the effect sizes ranged from medium (0.59) to large (0.91). A summary of these findings is found in Table 3.

Table 3

Comparison of Differences in Achievement by Home Access

Group	Score: Access	Score: No Access	p-values	Cohen's d
Overall	151	121	<0.0001	0.90
Standard Error	(0.7)	(1.4)		
NSLP Eligible	137	118	<0.0001	0.59
Standard Error	(0.6)	(1.3)		
Non-NSLP Eligible	162	133	<0.0001	0.91
Standard Error	(0.8)	(3.1)		
White	158	131	<0.0001	0.87
Standard Error	(0.8)	(2.2)		
Black	134	114	<0.0001	0.63
Standard Error	(1.1)	(1.9)		
Hispanic	138	116	<0.0001	0.67
Standard Error	(0.7)	(1.9)		

How do students use computers for writing in school?

When teachers were asked whether their students used a computer to draft and revise writing, 20% reported never or hardly ever, 37% reported sometimes, 26% reported very often, and 17% reported always or almost always. The largest group of

students had teachers who reported that students sometimes used a computer to draft and revise writing (37%) (Table 4). Students whose teachers reported that their students use a computer to draft and revise writing had significantly higher average writing achievement scores (159) compared to students who never or hardly ever did (141), sometimes did (145), and very often did (154) ($p < 0.05$). The effect sizes of these differences ranged from small (0.15) to medium (0.52), as seen in Table 4.

Table 4

School Computer Use for Drafting/Revising Writing and Achievement

Use a computer for drafting/revising	Never or hardly ever	Sometimes	Very often	Always or almost always
Rate	20%	37%	26%	17%
Standard error	(1.2)	(1.4)	(1.4)	(1.2)
Achievement	141*	145*	154*	159
Standard error	(1.2)	(0.8)	(1.1)	(1.9)
Cohen's *d*[a]	0.52	0.41	0.15	

* = Significantly different from always or almost always ($p < 0.05$)
[a] Cohen's d is computed compared to "Always or almost always"

Do differences in drafting/revising writing with a computer in class exist between socio-economic groups?

Table 5 indicates that students who were NSLP eligible were significantly more likely to have a teacher report that their students never or hardly ever use a computer to draft and revise writing (25%) than students who are not eligible (16%) ($p < 0.001$). NSLP eligible students were also significantly less likely to always or almost always use a computer to draft and revise writing (12%) than those were not eligible (21%) ($p < 0.001$).

Table 5

School Use for Drafting/Revising Writing by NSLP Eligibility

Use a computer for drafting/revising	Never or hardly ever	Sometimes	Very often	Always or almost always
Percentage of NSLP Eligible Students	25%	40%	23%	12%
Standard error	(1.3)	(1.5)	(1.4)	(1.0)
Percentage of non-NSLP Eligible Students	16%*	34%*	29%*	21%*
Standard error	(1.1)	(1.6)	(1.6)	(1.7)

* = Significantly different from NSLP eligible ($p < 0.05$)

Are differences in draft/revising writing with a computer in class associated with computer-based writing achievement within socio-economic groups?

Looking at achievement within NSLP eligibility groups, among NSLP eligible students, those whose teachers reported that their students always or almost always used a computer to draft and revise writing scored significantly higher on average than those who never or hardly ever did and those who did sometimes ($p < 0.001$). Among non-NSLP eligible students, this group also significantly outperformed the other categories on average ($p < 0.001$), with the exception of "very often." The effect sizes ranged from Cohen's $d = 0.25$ to 0.38) (Table 6).

Table 6

School Use for Drafting/Revising Writing and Achievement by NSLP Eligibility

Use a computer for drafting/revising	Never or hardly ever	Sometimes	Very often	Always or almost always
NSLP Eligible	130*	133*	138	141
Standard error	(1.2)	(0.8)	(1.2)	(1.8)
Cohen's *d*[a]	0.32	0.25	0.09	
Non-NSLP Eligible	155*	157*	164	167
Standard error	(1.4)	(0.9)	(1.1)	(1.9)
Cohen's *d*[a]	0.38	0.32	0.1	

* = Significantly different from always or almost always ($p < 0.05$)
[a] Cohen's d is computed compared to "Always or almost always"

Do differences in drafting/revising writing with a computer in class exist between racial/ethnic groups?

As seen in Table 7, a significantly higher percentage of Black (25%) and Hispanic (24%) students never or hardly ever used a computer to draft and revise writing compared to White students (18%) ($p < 0.01$). Furthermore, a significantly higher percentage of White students always or almost always used a computer to draft and revise writing (19%) compared to Black (12%) and Hispanic students (12%) ($p < 0.01$).

Table 7

School Use for Drafting/Revising Writing by Race/Ethnicity

Use a computer for drafting/revising	Never or hardly ever	Sometimes	Very often	Always or almost always
White rate	18%	35%	28%	19%
Standard error	(1.5)	(1.9)	(1.8)	(1.7)
Black rate	25%*	40%	23%	12%*
Standard error	(2.0)	(2.2)	(2.3)	(1.2)
Hispanic rate	24%*	41%*	22%*	12%*
Standard error	(1.7)	(1.6)	(1.6)	(1.2)

* = Significantly different from White students ($p < 0.05$)

Are differences in draft/revising writing with a computer in class associated with computer-based writing achievement within racial/ethnic groups?

White students who always or almost always used a computer to draft or revise writing performed significantly better on average than White students who never or hardly ever or sometimes used a computer for this purpose (ps < 0.001) (Table 8). Black students who almost or almost used a computer for drafting and revising writing performed significantly better on average than those who never or hardly ever or sometimes used a computer (p < 0.001), and Hispanic students who always or almost always used a computer for this purpose performed significantly better on average than all three other categories (ps < 0.001). The effect sizes of the significant differences ranged from small to medium (Cohen's ds 0.28-0.48)

Table 8

School Use for Drafting/Revising Writing and Achievement by Race/Ethnicity

Use a computer for drafting/revising	Never or hardly ever	Sometimes	Very often	Always or almost always
White Achievement	151*	153*	161	164
Standard error	(1.6)	(0.9)	(1.1)	(2.2)
Cohen's d[a]	0.40	0.34	0.09	
Black Achievement	127*	131*	134	141
Standard error	(1.6)	(1.5)	(2.6)	(2.5)
Cohen's d[a]	0.43	0.31	0.22	
Hispanic Achievement Standard error	128* (1.5)	135* (1.0)	138* (1.4)	144 (1.8)
Cohen's d[a]	0.48	0.28	0.18	

* = Significantly different from always or almost always (p < 0.05)
[a] Cohen's d is computed compared to "Always or almost always"

Discussion

Looking across these data, there were significant differences in student computer access and usage across socio-economic status (as measured by NSLP eligibility) and race/ethnicity on the 2011 eighth grade NAEP writing assessment. NSLP eligible

students had significantly lower levels of home computer access than non-eligible students. Home access was also significantly lower for Black and Hispanic students compared to White students. There were also significant differences in writing achievement between groups with different levels of home computer access, both overall and within socio-economic status and racial/ethnic groups on the computer-based assessment. The effect sizes of these differences ranged from medium to large. These differences in home access across groups and writing achievement within groups demonstrate a need for further research on this topic, because home access was associated with higher writing performance. This suggests that low-income and minority students, who are less likely to have computers at home, may be at a disadvantage on computer-based writing assessments, widening achievement gaps.

When looking at school computer usage among NSLP eligible students, fewer teachers of Black and Hispanic students reported that their students used computers for drafting and revising writing in class compared to White students. Within groups, drafting and revising using a computer was associated with higher achievement outcomes on the writing assessment, which indicates that engaging in this practice may be beneficial for student writing. The effect sizes between different levels of school usage were small to medium (compared to the large effect sizes seen for home computer access), but school usage still presents an opportunity for future research and intervention aimed at reducing these achievement gaps.

It is important to note that these findings have clear limitations. Because this needs assessment used the NAEP Data Explorer interface, there was no method with which to control for other variables when considering race/ethnicity and socio-economic

status. Thus, the findings are not able to isolate one specific variable. The results of this needs assessment could not isolate causal relationships because of the use of *t*-tests, which were only able to compare mean differences and the inability to control for multiple potentially relevant variables.

However, these needs assessment data showed that there is a clear need for future research into the nature of these gaps in computer access and usage and how they are related to computer-based writing achievement. These data also showed the need for a future intervention among NSLP eligible and minority students aimed at closing the gaps that exist in achievement on digitally-based assessments. The intervention proposed in the next chapter may help to fill this gap. Intervening at the home access level or school usage level would be the most beneficial for these populations of students based on the findings of this needs assessment. The consistent gap in performance between socio-economic and racial/ethnic groups was evident. The findings were a clear call to action for researchers to work to understand and bridge the digital divide that exists in the United States.

Chapter 3

Interventions to Support Computer-based Writing Achievement

A review of the literature on equity in computer-based assessment found that many students in the U.S. face inequity in computer access and usage, known as the digital divide (Attewell, 2001; Deursen & Dijk, 2019), and face academic achievement gaps (Pitre, 2014; Vanneman, Hamilton, Baldwin, & Rahman, 2009). These gaps in computer access and usage, as well as in overall achievement, may present a challenge for low-income and minority students when engaging with computer-based writing assessments. Data from a needs assessment using a nationally-representative 2011 grade eight, computer-based writing assessment from the National Assessment of Educational Progress showed gaps in home computer access and school computer usage. A lack of home computer access and school computer usage was associated with lower performance on the timed, computer-based assessment.

Computer access and usage have also been found to be related to positive achievement outcomes (Attewell & Battle, 1999; Borzekowski & Robinson, 2005; Casey et al, 2012; Fiorini, 2010; Nævdal, 2007; Ponzo, 2011; Schmitt & Wadsworth, 2006; Weerdenburg, Tesselhof, & Meijden, 2019), suggesting that an intervention aimed at providing computer access and usage can better prepare students for computer-based assessments and address achievement gaps. A successful intervention to address these gaps in digital literacy and achievement may provide students with the opportunity to use computers in the classroom to improve their digital literacy skills and proficiency with computer-based writing.

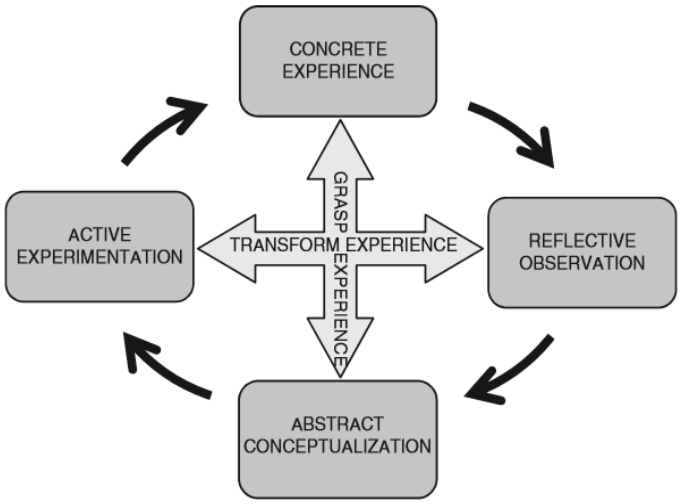
In order to create an intervention to address the digital divide, relevant skills and factors must first be identified. Variables from the needs assessment that had a particularly significant relationship with writing performance included home computer access and school computer usage. The relationships between these variables and achievement provided some potential areas for intervention that inform this intervention literature review. This chapter explores the extant research on approaches to address these writing achievement gaps. Intervention literature was reviewed and applied to the problem of equity in computer-based writing assessments, and the implementation of future interventions was discussed through the framework of Experiential Learning Theory (ELT) (Kolb, 1984).

Synthesizing the Literature Using Experiential Learning Theory

Experiential Learning Theory provided a framework for synthesizing the literature on computer-based writing. ELT is a cyclical learning model, derived from the ideas of Lewin, Dewey, and Piaget, that emphasizes the importance of cognition, experience, perception, and behavior in creating knowledge through interactions with environments (Kolb, 1984). Students must gain experience interacting with digital environments to develop digital literacy skills. The presence of a digital divide, defined as a lack of computer access and usage (Attewell, 2001), directly impacts student equity on computer-based writing assessments because low-income students may have less experience in digital environments at home and school than their higher income peers. ELT directly informed the planning of an intervention in this area because it provided a model for how learning occurs that was centered on direct experience in the learning environment and how learning was built from that experience.

Students must have experience with computers in order to develop digital literacy skills (Attewell, 2001), which makes ELT a relevant framework for an intervention related to increasing student experiences with computers to improve digital literacy skills. Kolb (1984) postulated that learning cannot be understood simply based on a particular outcome, but must be understood as an ongoing process, based in experiences, by which learners adapt to the world. This process-based model connects to other learning theories, such as constructivism, social constructionism, and cultural discourses (Quay, 2003). This continuous process of constructing knowledge from experience is described as a cycle made up of four stages: reflective observation, abstract conceptualization, active experimentation, and concrete experience (Kolb, 1984). Learners must engage in these four stages in order to develop skills and knowledge from their experiences. Applied to my problem of practice, a successful intervention should provide students with relevant experience using computers for writing and allow them to engage in the continuous process of building knowledge that they may be presently lacking due to the digital divide.

Figure 1. The experiential learning cycle (Kolb & Kolb, 2009).



Computer-Based Writing Intervention

In order to create a successful intervention regarding this problem, the literature was reviewed to identify areas for intervention and intervention approaches used in prior research. The assessment of need using a 2011 grade eight writing assessment identified two variables that were correlated with student writing achievement, including home computer access and school usage. The following literature review addresses the state of the literature on how to intervene on these specific variables. Both the needs assessment and intervention literature review helped to identify opportunities to intervene and the most effective approaches.

The potential impact of using a computer for writing instruction was supported by a study of the same data set used in the needs assessment, the 2011 grade eight computer-based NAEP writing assessment (Tate et al., 2016). Using structural equation modelling, a positive relationship was found between experience using computers for writing in school and writing achievement scores on the assessment. Demographic variables were accounted for in the analysis, which is particularly relevant because this review focuses on equity in computer-based writing and the digital divide. This research validated the findings and conclusions of the needs assessment, particularly emphasizing the role of school usage on writing achievement outcomes. The following section explores home access, school usage, and typing skill on student outcomes related to computer-based writing.

Home Access.

Home access is a component of Attewell's (2001) construct of the digital divide. Since the start of the 21st century, researchers have used this digital divide framework to

connect home access to computers with achievement outcomes. The relationship between home access and achievement outcomes suggests the possibility of improving achievement by providing students with access to computers at home.

Casey and colleagues (2012) examined home computer access using longitudinal survey data of nine-year-old Irish children. The children's computer use was unstructured, creating an opportunity for experimentation. The study found a positive relationship between home computer usage and standardized reading and math achievement (Casey et al., 2012). The outcomes of the study depended on the specific types of computer-based experiences in the home. When looking at specific variables, some had positive relationships with achievement (e.g., exploring the internet for fun, using the internet for research, and sending emails) and others had negative relationships with achievement (e.g., instant messaging and downloading music or movies) (Casey et al., 2012). These results suggest that, while home access was positively correlated with achievement outcomes, the specific types of usage at home can have different impacts.

Home access was also examined in Fairlie and Robinson's (2013) study of the effects of home computer access on measures of student achievement. In a randomized controlled experimental study of 1,123 students in sixth through tenth grade from 15 different California schools, researchers provided computers to students who did not have home access and compared them to other students who also lacked a home computer (Fairlie & Robinson, 2013). The researchers in this study provided a computer but did not provide any training or instruction for how the computer should be used (Fairlie & Robinson, 2013), concluding that computer ownership had no effect on grade point average, test scores, discipline, or attendance.

While home computer access may have had a positive relationship with student achievement, access alone was insufficient to improve computer-based achievement (Fairlie & Robinson, 2013). The specific type of usage mattered for improving student achievement outcomes (Casey et al., 2012). Providing home access was also a very resource intensive approach because of the high up-front costs of providing computers and the additional costs of maintenance and IT support. However, this research suggests that home computer access was a variable that should be measured throughout a computer-based intervention focused on equity, even one that did not take place in the home environment, because students with home access to computers may have had different levels and types of experience with computers than those who did not.

School Usage.

School computer usage for writing instruction has been found to have a positive relationship with writing achievement outcomes on computer-based assessment (Tate et al., 2016). Data from the needs assessment demonstrated that the highest-leverage digital writing practices to address this problem were related to how computers were used in school. Using a computer to draft and revise writing was linked to higher writing performance. This practice is a school-based form of focused, concrete experience using a computer, which could represent a potential area for intervention. Yet, school usage as defined by NAEP only provided a broad survey-based measure and only included a few specific types of computer usage in schools. This intervention literature review delves into what previous literature has said about how school usage in real world settings helps inform the intervention design. Intervention research on school usage was examined in this review through both teacher-based and student-based approaches.

Teacher-based intervention.

Researchers have addressed this problem of practice by providing opportunities to support and promote teacher digital literacy and the integration of technology into the writing classroom. In a synthesis of research on one-to-one computing initiatives, Penuel (2006) found that factors associated with positive outcomes included teacher professional development, technical assistance, and positive teacher attitudes towards students' use of technology. This suggests that an intervention aiming to promote digitally based writing outcomes should consider teacher-based components described in this section.

When presented with the opportunity to integrate computers into their instruction, classroom teachers varied in how much they were able to successfully incorporate technology (Blau, Peled, & Nusan, 2016). While some teachers were able to facilitate student learning and collaboration using technology, others struggled with classroom management when working with technology. These findings suggest the need for any intervention to incorporate teacher training to promote positive student outcomes in computer-based writing. Based on this literature, coaching support for classroom management could be a useful component of a computer-based writing intervention.

In one study that used professional development to intervene in student digital literacy, the implementation of a technology immersion program had a positive impact on teacher attitudes toward technology, digital literacy skills, and the frequency with which they integrated technology into classroom activities (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010). This study examined the impact of a governmental grant that provided laptops to all students in 21 low-performing Texas schools. The grant also provided professional development and pedagogical support to teachers to support the

use of technology in instruction. The study used longitudinal survey data collected over three years to suggest that increased access and training using technology led to better teacher practices and attitudes toward technology (Shapley et al., 2010). While this research found that the teacher-based intervention improved teacher attitudes, it did not show improved student achievement outcomes, which is the focus of the present study. These findings emphasize the importance of considering teacher training when developing an intervention to address computer-based writing achievement. This teacher technology training should include training on specific digital literacy skills and classroom management strategies.

Other research used a teacher-based approach and found positive outcomes on student attitudes (Gibson, Stringer, Cotten, Simoni, O'Neal, & Howell-Moroney, 2014). This intervention provided teachers with (1) a week of summer training sessions focused on utilizing technology in the classroom, (2) lesson plans and curricula, and (3) assistance with creating technology-based lesson plans. Researchers studied the impact of this intervention on 45 fourth and fifth grade teachers in the Southeastern U.S. Survey data collected from 696 students in 10 urban public schools on their attitudes toward computers showed that teacher professional development training positively impacted student attitudes. The results indicated that this teacher-training intervention was associated with improved student attitudes toward technology and the use of computers for learning, though there was no evidence that these findings were related to changes in teacher attitudes. Evidence shows that teacher attitudes toward technology impact computer use during instruction (Drossel, Eickelmann, & Gerick, 2017), and these improved student outcomes, unrelated to the effect of the intervention on teacher

attitudes, suggest that a potential intervention should support positive experiences with technology for teachers as well as students.

Another teacher-based intervention across seven low-income suburban schools in 27 Auckland, New Zealand, classrooms found that monthly professional learning communities (PLCs) may accelerate student writing achievement gains (Jesson, McNaughton, & Wilson, 2015). This mixed-methods study collected data from classroom observations and teacher interviews, as well as student achievement data measured by a standardized online assessment graded by teachers using a rubric. Using a PLC as an intervention, the study identified best practices and applied them to other classrooms (Jesson, McNaughton, & Wilson, 2015). The best practices discussed in this research included increased learning interactions and teaching of higher order thinking. By giving students opportunities to compose writing and promote critical thinking, teachers were able to promote positive writing outcomes in digital environments (Jesson, McNaughton, Rosedale, Zhu, & Cockle, 2018). These best practices inform an intervention by informing the design of learning experiences that increase interactions through writing tasks which require higher level thinking.

The studies in this section looked at a number of different ways that teachers could be trained to use technology in their classrooms. The outcomes of these teacher-based interventions were focused on attitudes towards technology and best practices incorporating technology into the classroom rather than writing achievement specifically. While these studies were not specific to student writing achievement, they were useful because they helped inform how to train teachers to incorporate technology in the classroom and pointed to the need to include attitudes as an outcome measure for both

teachers and students. These results showed that teachers play an important role in how technology is used in the classroom, and that it was necessary to look further into how students are using the technology before designing an intervention. A teacher-based intervention is one potentially effective approach to shaping how students engage in computer-based writing in the classroom. Even a strong student-based intervention should consider and support teacher training as well. These findings suggest that an intervention to address digitally based writing achievement should include teacher support, such as coaching or PLCs.

Student-based intervention.

Another intervention approach that has been used to address gaps in computer-based writing achievement is providing students with in-school experiences using computers for writing. Student experiences with technology were found to be related to student writing achievement on computer-based assessments (Tate, Warschauer, & Abedi, 2016), making student-based interventions relevant in addressing digital divides. Additionally, providing opportunities for students to practice digitally-based writing was found to be a necessary component of developing student agency with technological tools (Dahlström, 2019). These digital writing environments also have the potential to motivate students because they are relevant to students' experiences in the modern world (Hodges & Morgan, 2017). This section explores student-based interventions specific to computer-based writing achievement that inform an intervention design.

School usage of Google docs.

The implementation of collaborative computer-based writing through Google docs has been found to enhance writing instruction (Denton, 2012), promote

collaboration (Krishnan, Cusimano, Wang, & Yim, 2018; Lin, Chang, Hou, & Wu, 2015), increase student motivation (Liu & Lan, 2015), and help meet the Common Core Writing and College and Career Readiness Standards (Yim, Warschauer, Zheng, & Lawrence, 2014). The findings from these studies on the positive impacts of Google docs as an instructional tool, which supports its use in an intervention aimed to address achievement gaps in digital writing.

In recent years, a body of research has developed on the use Google docs as a form of collaborative computer-based writing intervention. Gierhart and Brown (2018) found that implementation of Google Classroom allowed a third grade teacher to create a student-driven learning environment by sharing resources online, collaborating with students on writing projects, and providing feedback through Google docs comments. Through the use of Google tools, including Google docs, the teacher was able to enhance existing writing curriculum through additional collaboration and feedback in a digital environment. A future intervention could examine the extent to which students benefitted from additional collaboration, feedback, writing practice, or simply from having the opportunity to practice using a digital tool.

Interventions that used Google docs also led to improved student attitudes toward technology (Yim et al., 2014). In one study, sixth through eighth grade students in a suburban Colorado school used a cloud-based environment to write collaboratively and practice Common Core State Writing and College and Career Readiness standards. Data collected through 16 interviews with students and staff, a survey of 2,152 students, sample student work from 3,537 documents, and 10 hours of classroom analysis found that students who used Google docs as a cloud-based environment for writing had more

positive attitudes toward digitally-based writing (Yim et al., 2014). These findings suggest that providing writing practice and collaboration through Google docs may improve attitudes toward computer-based writing, though it remains unclear whether students benefitted from writing practice and collaboration or from using the digital tool.

Analyzing data collected from the same sample, Yim, Warschauer, and Zheng (2016) used qualitative measures to examine the implementation of a Google docs-based writing curriculum. They found that students, teachers, and school officials viewed Google docs as convenient and cost-effective, and they also stated that it enhanced productivity and provided opportunities for writing practice and instruction. Google docs improved writing skills through feedback, revision, and sharing. While these writing skills can be practiced in other ways, these findings inform how Google docs can be an effective tool for these practices. These findings further support the use of these specific practices through Google docs as a means to create computer-based writing experiences for students, and it provided a model for qualitative data collection methods, including interviews with students and teachers, surveys, student work analysis, and video of student engagement in computer-based writing activities.

Using Google docs for writing instruction has also created an opportunity for students to learn through collaboration. Krishnan and colleagues (2018) provided opportunities for rural American middle school students to write independent and collaborative essays using Google docs for outlining, drafting, and revising their writing. Students who used Google docs collaboratively produced longer and better quality writing than their peers who completed the task using Google docs independently. While both groups used Google docs, the students who had the opportunity to collaborate with

peers using the tool reported a more positive learning experience in addition to producing better writing samples. Because both the treatment and control groups in this study had the opportunity to use Google docs, these findings suggest that collaboration using Google docs should be incorporated into an intervention design. However, this study did not compare the use of Google docs to writing instruction without Google docs and did not measure writing achievement. These represent two areas for future intervention to expand on the findings of Krishnan and colleagues (2018).

Typing skill.

Engaging in computer-based writing activities requires students to type using a keyboard while also using cognitive resources to generate writing ideas. This suggests that computer-based writing requires student writers to divide cognitive resources between keyboarding and writing content (Barkaoui, 2014; Poole & Preciado, 2016). Developing keyboarding automaticity through practice enables students to focus cognitive resources on writing, rather than typing. Therefore, providing concrete keyboarding experience may be an important aspect to include when designing an intervention to improve student achievement on computer-based writing assessments.

To examine the impact of explicit keyboarding instruction on typing speed and accuracy, Marom and Weintraub (2015) provided students with biweekly touch-typing lessons using keyboarding software. The authors reported that explicit keyboarding instruction improved student typing speed and accuracy for both normal-achieving students and students with learning disabilities (Marom & Weintraub, 2015). Because computer-based writing assessments are timed, typing speed may impact students' ability to express their content knowledge.

A study from The Netherlands found that elementary students who engaged in a touch-typing program showed improved outcomes in spelling and narrative writing compared to those in a control condition (Weerdenburg, Tesselhof, & Meijden, 2019). Teachers in this study were trained in the program and engaged via an online course in preparation for the intervention. They then taught students 15 modules on touch-typing and word processing. These modules took place for 1.5 hours every two weeks, during which students practiced using the home keys and typing sequences of letters. The results indicated that the intervention was positively correlated with spelling and narrative-writing skills on the computer. These findings suggest that quality curriculum and teacher preparation should be considered for this intervention. Teacher preparation may also help to improve teacher attitudes, which have been found to be predictive of classroom computer use (Drossel, Eickelmann, & Gerick, 2017).

Poole and Preciado (2016) looked at elementary school teachers' beliefs and practices regarding typing skills and found that teachers believed that touch-typing was important to student performance, particularly on standardized assessments. Findings also revealed that teacher beliefs did not align with teacher practices because few teachers reported having touch-typing instruction in their schools. Because of the positive relationship between teacher expectations for typing skill and student performance, it is important to consider the impact of teacher typing skill expectations in designing an intervention aimed at improving student's computer-based writing.

Conclusion and Proposed Intervention

A review of the literature was conducted on interventions that aimed to address the digital divide and achievement gaps in computer-based writing. The findings of this

review demonstrated that while home computer access was positively related to improved achievement outcomes, it was insufficient to address achievement gaps without targeting specific forms of computer usage (Casey et al., 2012; Fairlie & Robinson, 2013). School-based interventions that target specific digital writing skills were positively related to student outcomes (Marom & Weintraub, 2015; Yim et al., 2014; Yim et al., 2016). However, the school computer-usage studies reviewed focused on changes in attitudes (Gibson et al., 2014; Yim et al., 2014; Yim et al., 2016) and teacher-related variables (Blau et al., 2016; Shapley et al., 2010), not on computer-based writing achievement. Further research is needed to examine the impact of an intervention aimed to provide students with specific computer-based writing skills that they will need to succeed on assessments, in college, and in their future careers.

Data from the 2011 NAEP grade eight computer-based writing assessment indicated that school computer usage, specifically using a computer for drafting and revising writing, was positively related to writing performance. This literature review provided additional support for these findings by further linking school usage to writing achievement (Tate et al., 2016), demonstrating the benefits of computer-based writing in school (Yim et al., 2014), and of explicit keyboarding instruction (Marom & Weintraub, 2015). The results of the literature review and needs assessment supported using computers in the writing process and providing explicit instruction to improve typing skill as strong avenues for potential intervention. Additional research provided support for the use of Google docs as a platform to provide students with opportunities to collaborate, practice, and receive feedback during the writing process (Yim et al., 2014). This literature provided further support for the use of typing instruction in school to

improve student typing (Marom & Weintraub, 2015) and writing skills (van Weerdenburg, Tesselhof, & Meijden, 2019).

The intervention described in chapter four of this dissertation builds on the previous literature on the integration of digital tools for instruction by introducing computer-based writing into the classroom through the use of Google docs and Typing Agent. Based on the literature, this intervention included both teacher-based and student-based components (Gibson et al., 2014; Marom & Weintraub, 2015; Yim et al., 2014). In the proposed intervention, teachers were provided with coaching on how to incorporate Google docs and Typing Agent into their writing instruction.

This intervention provided students with direct classroom experience using Google docs to engage in computer-based writing practice. Over the course of a six-week writing unit, students used Google docs throughout the writing process to draft, revise, and publish their writing. Classrooms engaged in their standard writing curriculum with the introduction of Google docs as an additional tool for writing tasks. Teachers used the DC Public Schools elementary literacy curriculum, which was aligned to Common Core State Standards. Based on the teacher-training components identified in this review (Blau et al., 2016; Gibson et al., 2014), I provided teachers with assistance with classroom management and with creating technology-based lesson plans during coaching weekly sessions focusing on how to implement their curricula through Google docs. This addition of Google docs into the writing curriculum followed on previous research using Google docs (Denton, 2012; Lin et al., 2015; Liu & Lan, 2015; Yim et al., 2014; Yim et al, 2016), while extending this research to measure computer-based writing achievement.

Keyboarding is another form of computer-based writing experience that was provided during the intervention. Over the course of the intervention, students used Typing Agent software to practice keyboarding skills. Typing Agent was the software used for keyboarding instruction because DC Public Schools had existing access to this program. Keyboarding instruction was planned to be provided to students, aligned to the approach used by Marom and Weintraub (2015). This explicit keyboarding instruction aimed to provide students with touch-typing experience and feedback on their typing speed and accuracy. This practice was intended to increase automaticity in the typing process to improve student typing skill. Teachers were provided with coaching support on classroom management during typing practice and handling technical issues. Providing students with keyboarding practice in class complemented the use of Google docs by providing students with experience using two different technological writing tools in the classroom.

This intervention addressed a gap in the literature by connecting these instructional practices to computer-based writing achievement. Students learned how to use the keyboard, engaged in writing tasks, and revised writing using Google docs. Teachers received coaching on how to plan writing lessons, manage the classroom when using computers, and support positive student attitudes towards computer-based writing through positive narration. Engaging in the learning process within a digital environment was aimed at helping students develop digital literacy and writing skills needed for college and career.

Chapter 4

Intervention and Evaluation Design: Method and Procedures

Given existing achievement gaps and the impact of the digital divide, computer-based assessments may introduce additional inequity into an already unequal system by changing the testing environment (Tate et al., 2016). An intervention was needed to address gaps in achievement in computer-based writing assessments to prepare students for college and careers in the 21st century. The objective of the intervention was to provide students with computer-based writing experiences that they need for computer-based writing assessment. The intervention included teacher coaching on how to utilize Google docs and Typing Agent as tools for writing instruction and provided students with in-class opportunities to use these tools. This chapter describes the method and procedures of the intervention.

Procedures

The intervention was provided to fourth and fifth grade students at two schools. One class of students at each school received the intervention over a six-week period. During this time, students engaged in one writing lesson per week using computers. Teachers also received weekly coaching during the six-week intervention on how to implement Google docs and Typing Agent as well as how to effectively manage the classroom. The control condition consisted of classroom writing instruction without the use of computers in one class at each school. After the conclusion of the intervention, classes in the control condition also received the treatment for six weeks to ensure equity.

Recruitment and group assignment.

I recruited teachers and principals in two schools with a departmentalized model in which one teacher per school teaches two classes of students in the same grade. Only Title I schools were recruited, and I selected sites with a mixed-level (untracked) general education classroom to ensure comparability between classes. I had a previous relationship with the principals of the participating schools from my work as a teacher and a teacher educator. The principal of each school recommended a teacher, and each teacher agreed to participate. Class grade levels were based on principal recommendations. One principal recommended recruiting from the fourth grade while the other recommended recruiting from the fifth grade.

Participants included a sample of fourth and fifth grade students enrolled in DC Public Schools. Fourth and fifth graders were both sampled because the PARCC writing rubric is the same for both grades and because those were the grades recommended by the principals of the participating schools. Between the initial planning meeting and the first coaching check-in, teachers provided students with informed consent forms to bring home to families. The informed consent form provided information about the researcher, the purpose of the study, the procedures, and the risks/benefits of participation. Teachers also obtained student assent and conducted the demographic survey. Students who did not provide informed consent still participated in the writing activities planned by the teacher, but their data were not collected.

After collecting student consent forms and demographic data from teachers, I used a random number generator to determine the treatment and control groups for the first six-week period of the intervention. Each student was given a participant ID number

to allow for deidentification of student data. Teachers were informed of group assignments at the first coaching check-in.

Teacher planning and preparation.

Prior to the beginning of the intervention, I met with school leaders at each research site to ensure that the requirements of the research were clear and could be met by school personnel and resources. I requested feedback from school leaders to prevent obstacles from arising and to help enable the successful implementation of the intervention. A point of contact was established at each school to help navigate problems with technology in each schools' computer labs.

At the beginning of the intervention, participating teachers met with me for a pre-intervention planning meeting to review intervention procedures. This meeting took place in each school's computer lab to ensure the technology functioned and the teacher had access to the necessary student login information for Typing Agent and Google docs. During this session, we reviewed informed consent forms, discussed group assignment, prepared for baseline data collection, and planned the first writing lesson (aligned to the overall unit plans that were created during the initial planning meeting) for the treatment group. We also discussed activities for the control groups.

Each week during the intervention, I met with each teacher for a weekly coaching meeting. The goal of each coaching session was to ensure that teachers were prepared to use computers within the writing curriculum. It was also an opportunity to conduct teacher interviews on their experiences while implementing the intervention and an opportunity to problem solve any concerns or obstacles.

Google docs for writing instruction.

Google docs was used during writing activities in the treatment condition. Teachers implemented the lesson plans created during the previous coaching check-in session. I worked with the teachers during check-ins to go over lesson plans, prepare materials, and resolve any questions about implementing Google docs during writing instruction. During these weekly check-ins, teachers were encouraged and reminded to collaborate with students by providing feedback on student writing tasks by adding comments using the comment feature of Google docs.

Typing Agent for keyboarding instruction

Typing Agent is a self-paced touch-typing software provided to all DC Public School (DCPS) classrooms. Schools have administrative accounts where they can access student data and schedule keyboarding assessments. During weekly coaching check-ins, I encouraged teachers to instruct students to use Typing Agent during intervention lessons and during other instructional times for students in the treatment condition. Students were prompted to use Typing Agent at least once per week. In Typing Agent, students first read passages and then had to type them in order to earn points, which they could then use to play typing practice games.

Evaluation

Several different components of the intervention were examined separately, including whether the intervention was implemented as designed, the extent to which students engaged in the intervention, the effects of the intervention on student writing and typing skill, and student experiences during the intervention. These aspects are examined through the following research questions.

Process research questions.

- RQ1: To what extent did teacher use of computer-based tools for writing instruction (Google docs and Typing Agent) adhere to the intended intervention design?
- RQ2: To what extent did students participate in the computer-based writing practices throughout the intervention?

Outcome research questions.

- RQ3: What effect, if any, did computer-based writing instruction have on student writing achievement outcomes as measured by the PARCC informational writing rubric?
- RQ4: What effect, if any, did Typing Agent instruction have on student keyboarding speed and accuracy?
- RQ5: What were students' experiences with computer-based writing during the intervention?

Evaluation design.

The intervention used a quasi-experimental design, which was evaluated using a mixed-methods approach. The use of a quasi-experimental design, as opposed to a true experiment, was necessitated by the inability to randomly assign students to classrooms for the purposes of the study and because I was unable to alter the content of the writing curriculum. The design of the intervention included both pre- and post-intervention assessment. A between-groups approach was used to compare differences in means between the treatment and control conditions.

To evaluate the first two research questions regarding teacher implementation and student participation, teacher interviews were conducted during the weekly coaching sessions and student metadata were collected. During each coaching session, I interviewed each teacher using interview questions aligned to the research questions (Appendix A) and coded the responses by identifying emergent themes, as described by Onwuegbuzie and colleagues (2009). The third research question was evaluated by comparing mean differences in writing achievement growth between the control and treatment conditions. The fourth research question was evaluated using Typing Agent data on typing speed and accuracy to compare writing skill between the treatment and control conditions. Focus groups were conducted at the conclusion of the intervention to evaluate the fifth research question and understand student experiences.

Taking a mixed-methods approach allowed for a robust understanding of the effects of engaging in computer-based writing instruction by providing both quantitative and qualitative data. It was hypothesized that the intervention would improve computer-based writing and keyboarding outcomes based on the assumption of adherence to the intervention design as described above.

Method

Student demographic data was collected from teachers at the beginning of the intervention, including race/ethnicity, home computer access, and a proxy for socio-economic status (NSLP eligibility). These variables were identified in the literature review and needs assessment as being relevant demographic characteristics related to computer-based writing achievement. To evaluate the research questions above, data were collected on teacher experiences, writing achievement, keyboarding skill, and

student experiences. A combination of qualitative and quantitative measures was used to analyze the data and address the research questions. These measures, the instruments and materials used for collect these data, and data analysis are described below.

Measures.

Instruments.

Teacher interviews (RQ1-RQ5).

During each coaching session, I conducted a one-on-one interview of each teacher. These interviews included questions pertaining to all five research questions, including fidelity of implementation, teacher experiences, student engagement, changes in student writing, changes in student typing skill, and observed student experiences during the intervention. The interview questions asked are found in Appendix A. To assess fidelity of implementation, I took fields notes recording the number of intervention lessons implemented, the number of teacher interviews conducted, and from my observations of intervention lessons.

Availability of computers (RQ1).

Before each intervention lesson, I collected data on the number of working computers in the computer lab. These data were collected in field notes.

Time using Typing Agent & Google docs (RQ1).

Teachers logged time spent on Typing Agent and Google docs during each intervention lesson. While I planned for teachers to submit these logs each week at the coaching check-in, these data were shared verbally because of time constraints.

Writing task completion using Google docs metadata (RQ2).

Writing samples from classwork were examined to identify whether or not students completed writing activities planned by the teacher. Data on Google docs writing completion and collaboration were recorded in an Excel spreadsheet.

Student attendance data (RQ2).

Teachers took attendance each day using a sheet with participant identification numbers and shared it with me during weekly coaching check-ins. Students who were absent for more than half of the days of the intervention were excluded from later analysis.

Table 9

Data Collection Matrix for Process Evaluation

Fidelity Indicator	Data Source(s)	Data Collection Tool	Frequency	Responsibility
RQ1 Availability of computers	Researcher-report	Field Notes	Before each lesson	Researcher
RQ1 Time using Typing Agent	Teacher-report	Teacher check-in	Weekly	Teacher
RQ1 Time using Google docs	Teacher-report	Teacher check-in	Weekly	Teacher
RQ1/RQ2 Teacher interviews	Weekly check-ins	Field Notes	Weekly	Researcher
RQ2 Writing task completion	Software meta-data	Google docs/Excel	Weekly	Researcher
RQ2 Student school attendance	Teacher-report	Teacher check-in	After each lesson	Teacher

Computer-based writing assessment (RQ3).

Writing was measured using the fourth-fifth grade PARCC writing rubric for informational writing. Teachers provided me with deidentified student writing assessments, enabling me to score these assessments while blinded to the treatment condition. The computer-based writing assessment was administered pre- and post-intervention. It consisted of a Google document shared with students that included a prompt and link to passages. The writing tasks were fourth grade, PARCC-aligned released testing items, which were chosen because fourth grade was the lowest grade that participated in the intervention. All writing tasks during the intervention were aligned to informative writing to ensure a consistent rubric.

Typing Agent assessment (RQ4).

Typing speed and accuracy were measured by the Typing Agent software. Accuracy was calculated as the percentage of characters typed correctly during the assessment. Speed was calculated in words per minute typed during the assessment. Students completed a pre- and post-intervention assessment on Typing Agent. The teacher or a school administrator provided me with these data.

Student experiences with computer-based writing focus group (RQ5).

A focus group was conducted on student experiences at the end of the intervention. Students were asked five questions about student experiences with computer-based writing throughout the intervention (Appendix B). The focus group was recorded and then transcribed to allow for analysis of emergent themes.

Table 10

Data Collection Matrix for Outcome Evaluation

Outcome Variable	Data Source(s)	Data Collection Tool	Frequency	Analyst
RQ3/RQ4/RQ5 Teacher interviews	Weekly check-ins	Field Notes	Weekly	Researcher
RQ3 Writing achievement	PARCC-aligned writing task	Google docs	Two times (pre and post)	Researcher (blinded to condition)
RQ4 Keyboarding skill	Diagnostic assessment	Typing Agent	Two times (pre and post)	Typing Agent
RQ5 Student experiences with computer-based writing	Student response	Focus group	At intervention conclusion	Researcher

Materials.

Google docs.

Google docs is a free web-based word processing program. Google drive folders were created for each class. I created these folders using deidentified participant ID numbers and maintained them during the intervention.

Typing Agent software.

Typing Agent is keyboarding software provided to all DC Public School students. The district has already created student usernames and passwords for this software. Schools have access to these data through an online application.

Computers.

Participating classrooms provided all students in the treatment condition with computers that had internet connections during writing instruction. At both schools, the computers provided were desktop computers located in the school computer labs.

Data collection.

Baseline data collection.

Prior to the first intervention lesson, all students completed a PARCC-aligned informative writing task and completed the Typing Agent pre-intervention diagnostic test. Each student accessed a document created with a PARCC released informative writing prompt at the top. Students had about 60 minutes to read the prompt and complete the writing task. Once the writing task was completed, they logged into Typing Agent to complete that assessment. All baseline data were collected in one class period. I downloaded all deidentified writing task samples in a combined folder for grading, which enabled me to be blinded to the treatment condition of each sample. Absent students completed the baseline assessments upon returning to school.

Weekly teacher coaching check-in protocol.

During the weekly coaching check-ins, a consistent protocol was followed to gather interview data, help the teacher plan computer-based writing lessons, address obstacles in implementation, and plan data collection specific for that week. A protocol for this meeting can be found below. Additional considerations for each weekly check-in are found below in the subsections for each week.

Teacher Weekly Check-in Agenda

1. Teacher interview (Appendix A)
2. Review Google Doc and Typing Agent time
3. Plan computer-based writing lessons for the week
4. Address obstacles

5. Prepare for subsequent data collection (e.g., assessments, survey administration, etc.)

Appendix A includes the specific interview questions that were asked during each coaching session. I took notes aligned to these questions in my field notes. I also offered additional supports regarding implementation as requested by teachers.

Outcome assessments.

After the six-week intervention, outcome assessments were administered. Students completed another PARCC-aligned writing task and completed a second Typing Agent diagnostic. These data were collected by the teacher and scored by me or the Typing Agent software, respectively. Having a single grader provided consistent scoring of writing assessments.

Focus groups.

Two student focus groups took place at the conclusion of the intervention. Each focus group consisted of four randomly selected students from each school. Four students from each school who had received the treatment were selected by randomly drawing student identification numbers from the student data Excel spreadsheet. All eight selected students agreed to participate in the focus group. Five questions about student perceptions and experiences during the intervention were asked during the focus group. These can be found in Appendix B. Focus groups were recorded, transcribed, and then analyzed by identifying emergent themes.

Data analysis.

Each research question was explored using a mixed methods approach. Both qualitative and quantitative measures were used to answer these questions. The data

collected above were analyzed using the protocols described below. The goal of these analyses was to enable the formation of valid inferences regarding the relationship between the intervention and student outcomes.

To evaluate research question one on teacher implementation, data were examined on computer availability, time spent on Google docs, time spent on Typing Agent, teacher experiences from weekly interviews, and lesson observations. Data on computer availability, time spent on Google docs, and time spent on Typing Agent were examined quantitatively. Sufficient time on Google docs was defined as a minimum of 20 minutes per lesson, while sufficient time on Typing Agent was defined as a minimum of 10 minutes per lesson. The researcher analyzed field notes and weekly teacher interview questions for emergent themes to answer research questions one.

Research question two was answered by analyzing writing task completion data, keyboarding progress meta-data, student attendance, teacher interviews, and lesson observations. Writing task completion, keyboarding progress, student attendance, and number of observed lessons were examined quantitatively, while teacher interviews were analyzed to determine themes in student participation. Writing task completion was considered sufficient if 80% of writing tasks were completed overall. Keyboarding progress was considered to be implemented with fidelity if 80% of students demonstrated completion of typing lesson modules. Attendance was considered adequate if it was at least 80% overall, while individual students who were present for less than 50% of intervention lessons were dropped from subsequent analysis.

To answer research question three, I examined teacher interview responses and conducted a quantitative analysis. Teacher responses in the field notes that reflected any

changes in student writing were selected and coded as positive, neutral, or negative. The quantitative analysis consisted of a between-groups analysis of variance (ANOVA) for writing achievement. The ANOVA compared the treatment group to the control group using change scores from the pre- to the post-assessment. If the findings from the ANOVA indicated a significant treatment effect, these data were disaggregated by school site to identify any differences in the effect between sites. Demographic variables of race and home computer access were collected to be included in the analysis based on the literature. However, these covariates were not used in the analysis because there was little variability in the sample. These demographic data are reported separately in the next chapter to provide context.

Teacher interview responses and quantitative analysis were also used to answer research question four. Teacher responses that reflected changes in typing skill were coded as positive, neutral, or negative. Typing data from Typing Agent were entered in a multivariate between-groups analysis of variance (MANOVA) to determine whether there was a difference in typing skill change from pre-assessment to the post-assessment between the treatment and control groups. Typing skill was reported as accuracy (percentage of words typed correctly) and as speed (words per minute).

Data on research question five collected through observation field notes and transcriptions of student focus groups were analyzed by identifying emergent themes. Both teacher interviews and student focus groups were analyzed separately for each school to uncover any differences between school sites. Themes were reported overall and by school site. These specific themes were organized according to whether they reflected attitudes that were positive, mixed, or negative towards the intervention and

computer-based writing. The questions asked in the teacher interviews can be found in Appendix A and questions from the focus groups can be found in Appendix B.

Data management.

Students were given a participant number after turning in the informed consent form. All student data were deidentified by the teacher using these participant numbers before sharing these data with me. I collected these data in an Excel file. Data collected from students, parents, and teachers were stored on a password protected laptop computer in my possession. Typing Agent and Google docs accounts were also deidentified and password protected. Following the completion of the study, paper surveys and materials will be stored for three years and then shredded. At the conclusion of the study, all online documents were removed from the internet and stored on a USB drive.

Conclusion

The intervention was designed to address the computer-based writing achievement gaps described in the assessment of need. The intervention design was informed by a review of the literature, which found evidence that Google docs and keyboarding instruction could be effective writing instruction tools to improve computer-based writing outcomes. The intervention aimed to promote computer-based writing achievement by providing students with opportunities to use Google docs and Typing Agent during literacy classes once per week.

One potential weakness of the proposed intervention methodology was the risk of external factors outside of my control affecting implementation of the intervention and the ability to evaluate it. These factors included teacher attendance, student attendance, student refusal to participate in the research, and differences in implementation between

teachers. I was not present during every intervention lesson, and teachers may have taken different approaches to implementing the intervention.

Having weekly coaching check-ins with teachers during a school-based intervention was a strength of the research design. Interview data gathered during these check-ins were helpful for understanding the intervention and could also be used to inform future research. Using these coaching check-ins to evaluate the implementation allowed for flexibility and adaptation to specific teacher needs, and it gave me opportunities to address potential problems before they arose. Another strength of the evaluation plan was the ability to collect data through Google docs and Typing Agent. Data were available from Typing Agent assessments and from writing task completion on Google docs.

The quasi-experimental between-groups design was both a strength and a limitation. This design allowed for the research questions to be evaluated in a real-world context, specifically within DC Public School writing classrooms. Using a between-groups approach allowed for comparison of the treatment condition with demographically similar students who engaged in writing instruction with the same teacher at the same school.

A limitation of this design is the lack of statistical power because only half of participants engaged in the treatment condition. Additionally, there is risk of contamination between treatment and control conditions since the same teacher is providing instruction to both groups. It is possible that skills reviewed in coaching check-ins could impact both the control and treatment conditions. The restriction of the sample

to DC Public School classrooms may limit the generalizability of the results to similar student populations.

Chapter 5

Results and Discussion

This chapter discusses the findings of an intervention designed to address gaps in computer-based writing achievement at two Title One public schools in Washington, DC. The intervention provided classes of fourth or fifth grade students with opportunities to draft and revise writing using Google docs, as well as to practice keyboarding skills using Typing Agent software. This intervention also provided teachers with coaching supports to implement these technological tools during writing instruction.

The intervention took place over six weeks and used a quasi-experimental design. Classes participated in the intervention across two schools. During the six-week intervention, one class at each school was in the treatment group while another class was in the control group. At the conclusion of the intervention, classes switched between the treatment and control conditions for an additional six weeks to ensure that all participating students received the treatment. Writing achievement and typing skill assessment data were collected at the beginning and end of the intervention.

Each week, I met with participating teachers separately for coaching check-ins. During this time, teacher interviews were conducted to collect qualitative data and to assist with process evaluation of the intervention. I supported teachers at each check-in as they implemented the intervention by providing coaching and problem-solving to address obstacles. At end of the six weeks, a student focus group was conducted with four students at each school to gather qualitative data on student perceptions and experiences.

After describing each research site, this chapter reviews intervention preparation and implementation in order to examine the fidelity to the design. Quantitative and

qualitative research findings are presented by research question. The chapter concludes with a discussion of the study findings, limitations, and implications for future research. The research questions explored throughout this chapter are as follows.

Research Questions

- RQ1: To what extent did teacher use of computer-based tools for writing instruction (Google docs and Typing Agent) adhere to the intended intervention design?
- RQ2: To what extent did students participate in the computer-based writing practices throughout the intervention?
- RQ3: What effect, if any, did computer-based writing instruction have on student writing achievement outcomes as measured by the PARCC informational writing rubric?
- RQ4: What effect, if any, did Typing Agent instruction have on student keyboarding speed and accuracy?
- RQ5: What were students' experiences with computer-based writing during the intervention?

Implementation

Description of research sites.

The two schools that participated in the study were DC Public Schools located less than one mile from one another in Washington, DC. Both were Title One schools where all students were eligible for free and reduced-price lunch and a majority of students were identified as Black. These schools are described as "school one" and "school two" for the remainder of this chapter.

School one.

School one was located in Ward 6 of Washington, DC. Over 90% of students at school one identified as Black. The intervention was implemented with two fifth grade classes during library class, which took place once per week in the afternoon. The computer lab was a separate room within the library. Due to the need for hardware maintenance, the lab contained between 19 and 26 functional computers each week.

Class 1A.

Class 1A participated in the treatment condition. Fifteen of the 20 students provided signed assent and consent forms, and two were later dropped due to absences, leading to a participation rate of 65%. The demographic breakdown of each participating class can be found in Table 11.

Class 1B.

Class 1B participated in the control condition. Sixteen out of 20 students provided signed assent and consent forms. One student was dropped due to absences, leading to a participation rate of 75%.

School two.

School two was located in Ward 5 of Washington, DC. Over 80% of students at school two identified as Black and the remaining students were almost all identified as either Hispanic or White. At school two, the intervention took place once per week on Wednesdays during literacy class. Intervention lessons took place in the literacy teacher's classroom. After each lesson, the teacher transitioned students from the classroom to the computer lab for independent work time on computers. The lab had from 14 to 24 working computers during the course of the study.

Class 2A.

Class 2A participated in the treatment condition. Seventeen out of 20 students provided signed assent and consent forms, and one student was dropped due to absences, leading to a participation rate of 80%.

Class 2B.

Class 2B participated in the control condition. Sixteen out of 19 students provided signed assent and consent forms. One student was dropped from the data set for being absent for more than half of the intervention lessons, leading to a participation rate of 79%.

Table 11

Student Demographics by Class

	Class 1A	Class 1B	Class 2A	Class 2B
Male	38%	40%	69%	33%
Female	62%	60%	31%	67%
Black	92%	87%	69%	93%
White	8%	-	6%	7%
Hispanic	-	13%	19%	-
More than one race	-	-	6%	-
Home computer access	92%	80%	89%	87%

Home access was identified in the needs assessment and literature review as being associated with positive outcomes. Therefore, a series of Bonferroni corrected t-test were conducted to investigate any differences in home access between classes. None of the differences in home access between classes were significant (all *p*s >.05).

Intervention preparation.

Research approvals to conduct the intervention and evaluation were obtained during the fall of 2018. School recruitment began after receiving Institutional Review

Board (IRB) approval and before submitting the research request to the school district. I emailed two principals at Title One elementary schools with whom I had an existing professional relationship and asked about their interest in participating in the study. These principals expressed interest and set up in-person meetings to discuss the intervention, citing their schools' emphasis on improving writing scores on PARCC.

Recruitment.

Teacher recruitment began after receiving approval from the school district. At school one, one teacher was recruited by the school principal and agreed to participate. I emailed this teacher and set up a time to meet during a planning period, during which I provided her with an informed consent form and assent and parent consent forms for her students. This teacher at school one, referred to in this chapter as "teacher one," was the school librarian who implemented the intervention during library class.

At school two, one teacher was recruited to participate in the study by the principal and is referred to in this chapter as "teacher two." Teacher two and I had a professional relationship before the intervention recruitment because we both taught elementary literacy in DC Public Schools. I was asked to meet with teacher two by the assistant principal during the school district's research approval process.

Initial planning meeting.

I met with both teachers for the initial planning meeting, during which we discussed the logistics for the lessons. Based on teacher schedules, it was determined that the intervention would take place once per week. Teachers were shown how to use Google docs to teach writing and provide feedback. They were then given access to a

Google folder, and I demonstrated how to create, draft, and share documents, as well as give feedback on student writing.

Each teacher and I reviewed the texts for the upcoming unit and determined two aligned writing tasks for students receiving the treatment condition. Lesson objectives and a calendar were established. A research plan was created following the meetings (Appendix C), which contained a calendar of lessons and check-ins, writing prompts, and six scripted lessons. Writing tasks for lessons were created from the DCPS curriculum, while assessment tasks were taken from released fourth grade PARCC assessments. At the conclusion of this planning meeting, the teacher and I scheduled our weekly check-ins and established next steps. At this stage, I created a private Google folder for each student labeled with their student ID number, which contained a document for each lesson prompt or assessment.

During this pre-intervention check-in, classroom management strategies were presented to help students work with computers, such as setting expectations, reinforcing positive behaviors, and celebrating student success. Teachers were taught to circulate the room while looking at student computer screens and how to help with technical issues and the writing process. Teachers were also shown how to project their computer screen on the overhead projectors so that they could demonstrate how to use the software, model the writing process, and present successful examples of student work. I showed each teacher how to provide comments and feedback on Google docs and encouraged teachers to add these comments and feedback to student writing during and after writing lessons. At the conclusion of this planning meeting, the teacher and I scheduled our weekly check-ins and established next steps.

Intervention implementation.

The intervention began with pre-assessments in January 2019 and concluded with post-assessments in February 2019. Teacher check-ins and interviews took place weekly. Both classes in the treatment condition participated in five out of the six planned lessons. The reasons for these adjustments are described in the fidelity of implementation section of this chapter. The following section describes the intervention assessments and lessons for each class to present a full picture of implementation for each class.

Pre-assessment.

Students completed the pre-assessment during library class at school one and during literacy class at school two. Students completed the Typing Agent pre-assessment first and then moved on to the writing pre-assessment. Overall, most students attempted the pre-assessment, although some students were unable to produce a relevant writing response or correctly type the first letter of the Typing Agent assessment. The behavior of some students, particularly talking, disrupted the pre-assessment based on my observations and student feedback.

I collected student writing achievement data by viewing student writing responses in each student's Google folder and scoring responses based on the PARCC rubric and PARCC scoring guide. I collected Typing Agent data at school one from a school administrator because teacher one did not have access to these data. At school two, teacher two gave me these data for participating students during check-in time.

Treatment condition.

Classes 1A and 2A were randomly assigned to be the treatment group. Lessons consistently took place on Fridays for Class 1A and on Wednesdays for Class 2A. A description of the first stage of treatment for Classes 1A and 2A is found below.

School one, Class 1A.

Lessons for Class 1A took place in the main area of library, and the transition into the computer lab used instructional time. During weekly check-ins with teacher one, coaching focused on classroom management, particularly setting and reinforcing expectations, and practicing upcoming lessons. Teacher one identified that she did not feel able to demonstrate typing while teaching the lesson, and asked me to help by typing during lessons. We also prepared the instructional materials for that day, such as anchor charts, writing utensils, and/or student handouts.

School two, Class 2A.

Lessons for Class 2A took place in the literacy classroom. Lessons were well organized, with students beginning each lesson having already read the passages and taken notes on them. The teacher also used a SMART board to project writing examples and show directions, and she demonstrated hand placement on a keyboard. Coaching during check-ins was focused on lesson implementation and providing feedback on student writing.

Post-assessment.

During the week of the post-assessments, both schools also had the Achievement Network (ANet) assessments scheduled. The ANet assessment is a computer-based, PARCC-aligned assessment that was given three to four times per year. This assessment

was used by the school district and teachers to monitor student progress throughout the year. The ANet measures the same constructs as the PARCC, reading comprehension and written expression and knowledge of language and conventions. After meeting with the school leadership and teachers, these stakeholders agreed to use the ANet responses as the post-assessment so that students would not have to take two writing assessments in one week. Although student writing took place as part of the ANet, rather than the planned post-assessment for the study, I scored the student responses. The teachers at each site used check-in time to allow me to view and score student writing responses from the ANet assessment.

The change of post-assessment from the research plan to ANet prompts led to two notable considerations. First, the ANet assessments were literary analysis tasks (LAT) for both groups, and the research plan was aligned to the research simulation task (RST). Both the LAT and RST use the same rubric, so there was a consistent measure for this indicator for all assessments. The second change was that the passages and prompts were different between fourth and fifth grade ANet assessments. I collected student writing achievement data by viewing student writing responses to each ANET prompt and scoring them on the PARCC rubric and PARCC scoring guide. I collected Typing Agent data during the scheduled class time for each class.

Focus groups.

At each school, I conducted a student focus group during the week of the post-assessments. Each focus group consisted of four students randomly selected from each school. Students sat around a table with a recording device and were asked the planned focus group questions (Appendix B). For each question, each student had the opportunity

to share a response and was then given a prompt such as "why," "say more," or "anything else to add" to provide an opportunity to expand upon each response. After each focus group, I listened to the recording and transcribed it.

Findings

Fidelity of implementation.

Overall, the writing instruction component of the intervention was implemented as intended based on lesson observations, teacher interviews, the availability of working computers, and the time each class spent on Google docs. Five out of six scheduled intervention lessons were completed at each school, during which all students had a working computer. Each class spent at least 80 minutes of class time engaging in writing work using Google docs. However, the implementation of Typing Agent instruction was unclear because I was unable to track time spent on Typing Agent as planned.

Adherence to intervention design (RQ1).

The following section answers the question: to what extent did teacher use of computer-based tools for writing instruction (Google docs and Typing Agent) adhere to the intended intervention design?

Students in the treatment group at both schools participated in five out of the six planned intervention lessons, had computers available, and were present for a majority of intervention lessons. During the weekly teacher interviews, I asked each teacher about their experiences implementing the intervention. I also observed almost all of the intervention lessons and took field notes. Findings from these measures indicated Google docs components of the intervention were implemented with fidelity by the teacher, while Typing Agent components were not.

Availability of computers.

Due to the need for students to use computers during each assessment and lesson, I observed the availability of computers before each session. There were sufficient computers for all classes to complete all lessons and assessments. The number of working computers available during the intervention ranged from 12 to 21 computers. See Table 12 for the number of computers available for each class. At school one, teacher one had up to three students sit outside of the lab at the computers in the library during work time. At school two, students either fixed the computers so that enough were working by the time of the lesson or teacher two asked other teachers to borrow two laptops for students to use. Intervention implementation adhered to the research design, as teachers at both schools were able to accommodate all students with a computer during all lessons.

Time using Google docs.

Teachers shared the amount of student time using Google docs at the beginning of each coaching check-in. Teachers at both schools estimated these times to the nearest five minutes. See Table 12 for the time spent on Google docs for each class. Overall, these times were as planned in the research design.

Time using Typing Agent.

During weekly check-ins, teachers reported student time on Typing Agent. Teacher one consistently reported that specific students spent up to 15 minutes per class on Typing Agent, while the majority of students did not log in at all because they were on another educational software or working on their writing sample. Teacher two reported that students logged into Typing Agent for varying lengths of time during class, and during another teacher's class. Teacher two could not report time spent per student. From

observations of lessons, most students at school two spent all of the time in the computer lab working on their Google docs essay, leaving no time to work in Typing Agent. Only time spent on Typing Agent during the first lesson was recorded for this measure because of the inconsistent reporting from teachers.

Students at both schools spent about either 20 or 30 minutes on Typing Agent during the first lesson and demonstrated a wide range of effort during the assessments. Both teachers reported that they prioritized students spending time on Google docs over Typing Agent during lessons, which reduced the time spent on Typing Agent. The lack of consistent reporting of the amount of time spent on Typing Agent makes it difficult to determine whether or not students participated in the planned amount of typing instruction, though time was provided during each lesson in which students could use Typing Agent after they had completed writing work.

Observations and teacher interview findings.

Based on data from weekly teacher interviews and lesson observations, the Google docs component of the intervention was largely implemented with fidelity, while the Typing Agent instruction was not because of time limitations and logistical barriers to implementation. Over the course of the six-week intervention, five interviews took place with teacher one and six interviews took place with teacher two. There were a different number of interviews because teacher one needed to cancel or reschedule check-ins because of school assemblies, schedule changes (e.g., substitute coverage), and personal obligations.

Findings from the teacher interview questions related to research question one indicated that teachers at both schools followed most of the scripted intervention lessons

and were able to facilitate time to use computers during each lesson. However, teachers at both schools did not use the comment feature of Google docs to give students feedback or implement the lesson on collaboration. While Google docs were used as an instructional tool for digital writing, the element of collaboration was not used as intended in the research design.

During interviews, teacher one reported that using computers seemed to be a "helpful experience" and that classroom management was the primary barrier to implementation, specifically students being "disrespectful" and "not paying attention." While teacher one worked on classroom management by scripting expectations during coaching sessions, there was little follow through during lesson implementation of the strategies reviewed based on lesson observations. Conversely, teacher two reported that students were "engaged" and "interested" in interventions lessons and did not report specific problems during check-ins. Both teachers liked that the intervention had students practice with computers. Teacher two expressed more comfort using the technology than teacher one.

I observed all intervention lessons at school one, as described in the intervention implementation section above. At school two, I observed five out of the six intervention lessons. Based on data collected in field notes from lesson observations and teacher interviews, I conclude that a sufficient amount of time was spent on the Google docs, but not Typing Agent.

Table 12

RQ1 Collected Data

Measure	Class 1A	Class 2A
Lessons Implemented	5/6	5/6
Teacher Interviews	5/6	6/6
Lessons Observed	5/5	4/5
Time on Typing Agent	20 minutes	30 minutes
Time on Google docs	85 minutes	150 minutes
Computers Available	16-21	14-20

Student participation (RQ2).

This section addresses the question: to what extent did students participate in the computer-based writing practices throughout the intervention? Overall, students participated in the Google docs component of the intervention, but not Typing Agent. Engagement in Typing Agent activities could not be established because students have access to Typing Agent in other classes and at home. Some students used Typing Agent outside of the intervention lessons, and during the lessons teachers prioritized time on computers for students to work in Google docs. Writing task completion and student attendance data support sufficient student participation in writing instruction through Google docs because it showed that students were present for lessons and completed tasks related to the lessons as outlined below. This was also confirmed through my observations of lesson implementation and teacher responses to the teacher interview questions.

However, student participation may have varied between school one and school two. There was a difference in teacher-reported student engagement between the two school sites, as teacher two described her students as mostly engaged, while teacher one indicated that many of her students were not engaged at various points during the

intervention. These data suggest a need to disaggregate findings by school to better understand the outcomes.

Writing task completion.

I used Google doc meta-data to collect writing task completion data. Each class engaged in two writing tasks during the intervention lessons. Writing task completion for each class is found in Table 13. Writing task completion was higher at school two than school one, particularly for writing task two. Overall, writing task completion was above 80% overall, supporting adherence to the research design.

Keyboarding progress.

I planned to access Typing Agent meta-data to track keyboarding progress during the teacher check-ins after each assessment. However, due to unforeseen barriers to access, the teachers were either unable to access these data because they lacked the necessary permissions or because they did not know the login information. I was able to view typing data from the assessments after asking school administrators, but I was unable to explore and report typing meta-data because these data could not be printed or transferred from administrators' computers due to privacy concerns. Due to the lack of meta-data, I could not establish whether or not students completed of Typing Agent activities as planned in the research outside of the first intervention lesson. Teachers reported that some students spent a great deal of time on Typing Agent while other students did not use Typing Agent during lessons.

Student school attendance.

Student attendance averages for each class (Table 13) were calculated after dropping students who missed 50% of the lessons from the data set, as described in the

research implementation section. Student attendance was adequate at 80% overall, ranging from 77% to 91%, but it was higher at school two than at school one. If a student was absent from the any of the assessments, I either conducted a make-up assessment within three days of the assessment during the same time of day or did not include that score in the data set.

Table 13

RQ2 Collected Data

Measure	Class 1A	Class 2A
Writing Task 1 Completion	85%	94%
Writing Task 2 Completion	62%	94%
Typing Agent Progress	-	-
Average Student Attendance	77%	91%

Observations and teacher interview findings.

Teacher one reported that students in the class were disengaged in the lessons for the first few intervention treatment lessons. Teacher one noted that the intervention took place at the end of the day when students wanted to go home. She also noted that the intervention took place during library class when students feel they can "play" and "gossip" because they do not receive a grade for this class. She described some students as "reluctant," "resistant," and "slow to get started." Other students were described as "willing" or "on task." Over the course of each set of treatment lessons, student engagement increased, and teacher one reported that "over half" of or "most" students participated in lessons and completed assignments.

Teacher two reported that students in the intervention group were engaged in all of the lessons. The teacher described how students used the same texts for reading lessons each week to prepare to write during the intervention lesson when she met with

me for the weekly check-ins. During the pre-assessments, teacher two described students as frustrated. Throughout the check-ins, she then noted that students seemed to be more comfortable in accessing their work in the Google folder and using the keyboard. By lesson three of the first stage of the intervention, teacher two indicated that keeping the anchor charts from the lesson in the computer lab was helpful to students.

Teacher two described students as "excited" and "eager" to use the computers during the intervention lessons because it was new and different from what they usually did during literacy class time. She also mentioned that they wanted to "show off" their skills in the computer lab. I observed that all or almost all of the students were engaged in writing work during worktime in the computer lab.

Outcomes

Student writing achievement (RQ3).

This section addresses the research question: what effect, if any, did computer-based writing instruction have on student writing achievement outcomes as measured by the PARCC informational writing rubric? Both teachers expressed during interviews that participating in the intervention was beneficial to their students' writing. To measure student writing achievement throughout the intervention, students completed two computer-based writing assessments, one prior to the intervention and one after the six-week intervention period. Classes 1A and 2A received the treatment, and classes 1B and 2B were in the control condition.

To evaluate whether student writing improved significantly during the intervention compared to the control group, I graded student responses from the pre- and post-assessments using the PARCC rubric, which has a scale from zero to four. Then,

change scores were calculated by subtracting each student's writing achievement score from the pre-test from that student's score on the post-test. A univariate between-groups ANOVA was run using those change scores to compare the treatment and control groups. There was significantly greater growth in the treatment group (m = 1.28) compared to the control group (m = .33) [$F(1, 57) = 24.513$, $p < .001$]. See Table 14 below for means, change scores, and standard deviations.

Table 14

Means, Change Scores and Standard Deviations of Student Writing Achievement by Group

	Pre-Score	SD	Post-Score	SD	Change Score	SD
Treatment group	0.38	0.56	1.66	0.90	1.28	0.80
Control group	0.50	0.57	0.83	0.70	0.33	0.66

Teacher interview responses indicated that there may have been differences in treatment implementation between the school sites, so an additional analysis was conducted to test for any difference in the treatment effect between school sites. There was no significant interaction between treatment and school site, indicating that there was no difference in the treatment effect based on the school site [$F(1, 55) = 1.416$, $p = .091$]. The overall treatment effect remained significant when including school site in the analysis [$F(1, 55) = 14.130$, $p < .001$] in spite of observed and teacher-reported differences in implementation. See Table 15 below for means, change scores and standard deviations.

Table 15

Means, Change Scores and Standard Deviations of Student Writing Achievement by Treatment Group and School Site

Group	Pre-Score	SD	Post-Score	SD	Change Score	SD
Treatment Group						
School one	0.15	0.38	1.85	0.55	1.69	0.63
School two	0.56	0.63	1.50	1.10	0.94	0.77
Control Group						
School one	0.33	0.49	0.73	0.59	0.40	0.51
School two	0.67	0.62	0.93	0.80	0.27	0.80

Data on research question three were collected during weekly teacher interviews (Appendix A). The interview questions prompted teachers to share their perspective on whether the intervention lessons impacted student writing ability. Both teachers indicated that they did not grade writing tasks between lessons and could not speak to the quality of the intervention writing tasks. Both teachers also indicated that students seemed more comfortable writing with computers as the weeks progressed. Teacher one did not feel she could speak to students' writing ability generally because she was the library teacher when asked questions related to research question three. Teacher two reported that students' writing skills improved, sharing that students were able to type more ideas in less time once they had explicit instruction on using a keyboard to write.

These results indicate that there was a positive effect of the intervention treatment on student writing achievement in a digital environment, in spite of classroom management issues. Student writing scores grew more on average for the treatment group than for the control group, and both teachers reported positive impacts on students.

Student typing ability (RQ4).

The following section answers the question: What effect, if any, did Typing Agent instruction have student keyboarding speed and accuracy? To answer this question, students completed two diagnostic Typing Agent assessments, a pre-test prior to the intervention and a post-test at the conclusion of the intervention. Typing skill was measured by typing speed, in words per minute, and accuracy by the percentage of words typed correctly. Change scores for these two variables were compared between the treatment and control groups.

Change scores were calculated for both typing speed and typing accuracy by subtracting each student's pre-assessment scores from their post-assessment scores. A multivariate between-groups ANOVA was run using these change scores to compare the treatment group and the control group. The results of this analysis indicate that the difference in Typing Skill growth between groups was non-significant [$F(2, 56) = 1.378$, $p = .261$]. Univariate tests of between-group differences examining Typing Speed and Typing Accuracy separately also yielded non-significant results [$F(1, 57) = 2.643$, $p = .110$ and $F(1,57) = 1.040$, $p = .312$]. For means, change scores and standard deviations see Table 16. These results indicate that there were no significant differences in typing skill between the treatment and control group. No further analyses were run due to the non-significant overall results.

Table 16

Means, Change Scores, and Standard Deviation of Student Typing Speed and Typing Accuracy

Typing Measure	Group	Pre-Score	SD	Post-Score	SD	Change Score	SD
Typing Speed (WPM)	Treatment	12.55	9.64	18.59	6.91	6.03	8.12
	Control	12.67	7.98	15.43	7.53	2.77	7.31
Typing Accuracy (%)	Treatment	61.66	35.33	82.69	18.56	21.03	32.34
	Control	62.13	33.35	72.63	31.05	10.50	45.66

While this analysis of the Typing Agent assessment data did not reveal significant differences, both teachers reported that students appeared more comfortable typing after participating in the intervention. Students' keyboarding abilities prior to the intervention were described by teacher one as "pecking the keys" and by teacher two as "using pterodactyl hands." By the end of the intervention, both teachers described that students were using both hands to type, some were using the home keys, and that they appeared more comfortable with typing. However, they also both reported inconsistent use of Typing Agent during the intervention due to Google docs being prioritized during writing class. This finding is confirmed from the lesson observation field notes. During my observations, some students were using the typing software consistently and others were not.

Student experiences (RQ5).

Student focus groups and teacher interviews were conducted to answer the question: what were students' experiences with computer-based writing during the intervention? Overall, findings from the focus groups and teacher interviews related to research question five indicated that students had an overall positive experience with the

intervention lessons and using a computer for writing. Both students and teachers described positive and negative aspects of student experiences during the intervention. During student focus groups and teacher interviews, students and teachers both described the benefits of typing over writing by hand and commented that students enjoyed aspects of working on the computers. Teacher two noted that students were excited to work on the computers, while teacher one described students as being disengaged (i.e., surfing the web, listening to music, or talking during instruction).

Students in the focus groups expressed an overall positive perception of the intervention, with some exceptions. I used transcriptions of the student focus groups to identify emergent themes that students expressed about their experiences, which I then grouped as positive, negative, or neutral. The most notable and relevant negative perception was the physical discomfort of using a computer for a long period of time. Students described the benefits of using computers and their desire to improve, while their teachers expressed that students did improve in their typing ability and comfort using computers during the intervention. However, students also expressed frustration with technical difficulties and pain from sitting at the computers for too long.

Positive themes.

Across both focus groups and teacher interviews, positive themes related to computer-based writing emerged. Teachers at both schools reported that students enjoyed Typing Agent in lesson one. Teacher one noted that students enjoyed the competition of the Typing Agent leader board, and both teachers expressed that the students enjoyed the games on the software. Both teachers also observed that students were typing more over the course of the intervention and that they seemed more comfortable with using

computers as the intervention progressed. Teacher two noted that students were excited and eager to write with computers.

Students at both schools also expressed a preference for typing over handwriting, though for different reasons. Some students at school one indicated that they preferred using the computer over handwriting because it would prepare them for PARCC testing. Students at school two expressed that they preferred typing to handwriting because it was less painful to type than to write with their hands. Some students at both schools also described computers as "fun" because they can also be used for research and to play games. Students discussed ways in which using a computer was novel and would help them to become better writers.

Several students noted the advantages of computer-based writing over pencil-and-paper writing. One student said "I like the features, like if you misspell a word it shows you, and you can click it and spell it right, and it helps with your grammar and stuff." Another student noted the advantages of using a computer: "I feel great about writing with computers because it is easier to write on the keyboard than with a pencil because your hands get tired when you are writing with a pencil instead of the keyboard." Multiple students in both focus groups indicated that using a computer for writing was "easy," citing how much easier it is to edit writing on a computer compared to paper and pencil. At both schools, students described the process of clicking within a document to make changes and how you cannot do that when handwriting. Additionally, students at both schools described a desire to type more quickly and to do so without looking down at the keyboard.

One student at school one described how his mother can type without looking, and said "I want to learn to type as fast as my mom. She can type and look at me and I want to do that to be like her." A student at school two expressed a desire to improve at typing and said "[What] I like best is that you can type a couple of times and stare at the keyboard, and you can memorize it eventually, and it can become really fast." These students expressed that they wanted to improve their typing through practice.

Negative themes.

Despite these positive attitudes towards computers, negative themes around computer-based writing instruction also emerged during the focus groups at each school. Both teachers reported that students seemed frustrated with computer-based writing during the pre-assessments during the teacher interviews. Teachers reported that some students needed help using the software and that these students sometimes disengaged when the teacher could not provide assistance during the assessments.

Another theme that emerged was around the physical pain of using a computer. As described earlier, two students at school two indicated that typing was less painful than handwriting. However, the same students also described neck pain from sitting at a computer for a long period of time. Some students also stated that they had pain in their necks from looking at the screen. Some students expressed the view that it is unhealthy to sit for long periods of time.

Students across both focus groups also expressed frustration at the technical difficulties involved with using computers and at the distractions caused by how their peers used the computers. At school one, students described how other students would play games or pull up pictures of scary images while using the computers for writing. At

school two, one student told a story about their cousin who accidently found inappropriate images or videos on YouTube, and said his cousin "was looking up his friend's YouTube channel and spelled it wrong, and something inappropriate came up." This student explained that he did not like using computers because he was fearful that this could happen to him.

Some participants from focus groups at both schools mentioned that they did not like the technical difficulties that come with using computers. Students at school one expressed that they did not like how the school blocked certain websites, and one student said "I dislike that you can block stuff to prevent people from going on it. [...] There is this game we all liked called cool math. It was about math. […]Why would you block that?" Another student described how their writing would accidently be erased while they were typing, and said "What I hate is that most of the time it glitches out and when I was doing my writing it accidently deleted the whole thing, and I had to start over." Students at school two described difficulty logging into their accounts and how other students could access their work if they did not completely sign out of their account. One student at school two expressed frustration about using other computer software that was not a part of the intervention. Specifically, she described how the mouse would move on its own and submit incorrect answers.

Neutral themes.

Additionally, neutral themes emerged across the focus groups at each school. When describing what they did with the computers, students at both schools consistently mentioned how they used Typing Agent and Google docs during instruction. They also both discussed other instructional software like Lexia, a type of reading software, and ST

Math, math software that they used. Additionally, students at both schools discussed what they learned from the texts read during the intervention. Specifically, students discussed the people they read about and how it connected to the research they were doing for Black History Month. Overall, students spent a great deal of the focus group discussing typing and Typing Agent, even though a greater amount of lesson time and focus was spent on writing with Google docs than on typing.

Discussion

A significant difference between student scores after the treatment condition versus the control condition was found for student writing achievement, but not for typing skill. While intervention lessons using Google docs for drafting and revising writing during lessons were mostly implemented as specified in the research design, typing instruction was not implemented with fidelity because of technical barriers. These differences in implementation may explain the difference in the results between the writing and typing components. Data collected from teacher interviews and a student focus group revealed that participants had a generally positive experience during the intervention, but that there were obstacles to implementation. The next section discusses these outcomes by research question to better understand these findings. Following a discussion for each research question, limitations and implications for future research are described.

Adherence to research design (RQ1).

The research design was largely implemented as planned for the writing component, but not the keyboarding practice. Implementation was affected by changes in schedule, technical difficulties, student behaviors, and differences between school sites.

These obstacles revealed the practical difficulties with implementing computer-based instruction in real-world classrooms. Although the students in the intervention have had access to cloud-based software and a sufficient number of computers for several years, implementation of the intervention revealed how underutilized these resources were. Students and staff were unfamiliar with the log-in process, as well as more task-specific processes like typing, formatting documents, and providing Google docs comments.

Implementation of the intervention revealed the amount of up-front time needed to implement computer-based practices. Additional time was needed prior to each lesson to set up the lab. In some instances worktime was spent identifying access to more computers rather than using Google docs and Typing Agent. Some students were aware of these delays and technical difficulties, and some students even fixed non-working computers during class time. The teachers needed my support to navigate resources and technology throughout the intervention. This suggests that teachers implementing computer-based writing practices need to consider the additional planning and preparation time needed to maintain computers and access the software. They may also need time to develop systems, routines, and procedures to ensure that they are able to manage the classroom while these lessons are implemented.

While there may have been enough equipment available for the intervention, the lack of reliability and perceived quality of the equipment may have impacted student and teacher engagement, perceptions, and experiences. This potential impact is seen through the negative themes coded in the teacher interviews and student focus groups. Specifically, both teachers and students described frustration around navigating challenges related to technology. While it was not measured directly, instructional time

spent setting up computers and overcoming technical difficulties may have impacted student perceptions and outcomes.

Google doc metadata supported the successful implementation of Google doc instruction at both school sites, as most students completed the writing tasks during the intervention lessons. However, responses to writing tasks ranged from one sentence to four well-developed paragraphs in length, indicating that there was variability in the amount of student writing ability and/or effort during lessons and assessments. Each lesson was planned to take place over about 60 minutes, but in practice each lesson took the duration of class time. At school one, library class was 60 minutes long, while at school two literacy class was 90 minutes long. This helps to explain why the classes at school two spent more time on Google docs than those at school one throughout the intervention. These differences in time spent on Google docs did not appear to impact the student writing achievement outcomes between school sites. This finding suggests that despite differences between the sites, the strength and dosage of the treatment were sufficient to reveal positive results. One teacher reported a lack of comfort using digital technology during instruction. But these results may indicate that students with little previous experience using digital technology for writing may improve even if the teacher is not comfortable using the technology. For these students, simply having class time dedicated to digitally-based writing may have been beneficial.

The time spent on Typing Agent was not measured quantitatively after the first lesson and varied between students according to teacher observations. During the student focus group, students frequently mentioned Typing Agent. However, students engaged most with Typing Agent during the assessments and the first lesson, and otherwise did

not spend as much time as planned on this software during treatment. The lack of sufficient time spent on Typing Agent could help to explain why there was no significant difference between the treatment and control groups with regard to typing skill. The obstacles encountered during the intervention also suggest the importance of training teachers on how to access and implement this software so that they can use the features and avoid technical difficulties.

Student participation (RQ2).

Based on classroom observations and teacher interviews, students at both schools participated in the treatment lessons and assessments, though students at school two appeared to be more engaged during the intervention lessons than at school one. The presence of non-engaged students and their potentially disruptive behavior may have impacted the engagement and performance of other students, particularly at school one, though there was no significant difference in the writing achievement treatment effect between schools. However, improved classroom management could have strengthened the treatment effect by helping students to concentrate. The shape of the computer labs at each school may have also contributed to off task behaviors and made classroom management difficult. The computer labs at both schools had obstructed views, making it challenging for the teachers to see all students and their computer screens from one place in the room. This suggests that when incorporating computers into instruction school leaders and researchers should consider how they create and manage space or use specialized computer software to aid in monitoring student activities.

Differences between teachers may also have contributed to the varying levels of student engagement at each school. Teacher two was an experienced literacy teacher who

worked with the students participating in the intervention on a daily basis, while teacher one had never taught whole-group writing and only saw participating classes once per week. These differences in teacher experience and relationships with students may have contributed to differences in student engagement between school sites. This may have led to some of the classroom management challenges, particularly at school one. Having the subject area teacher, the person most familiar with the instructional content, may facilitate student participation during lessons.

Another explanation for the differences in student participation may have been that the intervention at school one took place during library class, while the intervention took place during literacy class at school two. Library class was ungraded and was the final class of the school day. Teacher one reported that students were playful and disrespectful during library class prior to the intervention, and this behavior continued during the intervention. Students did not appear to buy in to the idea that they needed to put effort into their work during library class, despite classroom management support from their literacy and math teachers. Some students at school one used their computers to play games during work time, while the teacher at school two disabled the game feature on Typing Agent early in the intervention and monitored students more closely to ensure they were participating in the planned instructional activities. To maximize the benefit of computer-based writing instruction, students should be invested in learning, either through grades or through personal motivation.

When engaging in Typing Agent, students varied greatly in their level of effort, and some students did not engage in Typing Agent outside of the assessments and the first lesson. Several students became frustrated after making a mistake when typing the

first word on the pre-assessment, which occurred due to the need for capitalization. Some students appeared discouraged and stopped completing the pre-assessment, resulting in scores of zero on these assessments. In class, Typing Agent work time took place after the Google docs lessons. Some students continued to work on Google docs or began to socialize during this time. To effectively measure the impact of Typing Agent on student typing skill, students would need to spend sufficient time and provide attention and effort during Typing Agent activities. Because coaching sessions focused on teacher interviews and implementation of Google docs writing lessons, these findings may suggest need for more teacher planning and preparation for all software implementation.

Student writing achievement (RQ3).

Student writing achievement grew significantly more for the treatment group than for the control group. This aligned with the research hypothesis that engaging in the intervention would lead to improved computer-based writing outcomes. Despite the differences between the teachers and how the intervention was implemented, there were no significant interaction between school sites and the treatment. This suggests that differences in teacher adherence to the research design, classroom management, and length of lesson between schools did not lead to meaningful differences on writing achievement.

The use of the ANet assessment as the post-intervention writing assessment may have impacted the writing achievement results as well. Although the ANet writing responses were also graded by me using the same rubric as the other writing assessments, student effort and the context in which the assessment was completed may have differed. This assessment may have raised the stakes for students because it was an official school

assessment and the homeroom teacher was in the room during proctoring. The ANet assessment was also different from the other intervention assessments because students also had to answer multiple choice reading questions for the ANet exam prior to beginning their writing responses. However, the difference in growth between the treatment and control groups indicates that the treatment effect was robust to the impact of natural growth and the use of the ANet as the post-assessment.

The increase in student writing achievement scores after the treatment condition supports the use of cloud-based software to help students practice drafting and revising writing during writing instruction. However, the average student writing achievement score from the post-treatment assessment was 1.66 out of four. A score of three would be considered proficient, indicating that student achievement even after treatment was low relative to the proficiency standard. These findings suggest a need for further intervention to ensure that students reach writing proficiency.

The assessments in the intervention did not fully inform the mechanism by which using Google docs as an instructional tool to draft and revise writing may have been beneficial. From the lessons, students may have learned digital literacy skills, writing skills, or a combination of the two. The students may have learned specific writing and computer skills from the lessons or they may have improved because of the independent practice time. Digitally-based writing is a complex process, and additional research is required to assess which skills are impacted by digitally-based writing instruction. For example, neither teacher used the Google docs comment feature as a form of collaboration despite encouragement to do so during weekly check-ins. Rather, observations indicated that they used Google docs as a word processing software and

gave feedback verbally during lessons rather than leaving comments. These findings thus do not reflect the full use of all features of Google docs and do not identify the role of digital literacy instruction within writing instruction. These results do provide support for the use of Google docs as a word processing tool to provide students with computer-based writing practice, even without the collaborative features.

Student typing ability (RQ4).

Student typing ability did not change significantly throughout the intervention because of obstacles to implementation. These results indicated that there was no effect on typing ability from the intervention, though a future study may find significant effects with adherence to the prescribed time, more structured instruction, greater statistical power, or a longer duration of treatment. The teachers expressed that student typing time was less than had been planned, and student engagement during typing was inconsistent throughout the intervention lessons, which may help explain this finding.

The variability in student effort may have increased the amount of error in the typing measures. Additionally, the teacher at school one did not have administrator access to Typing Agent, so she was unable to look at student meta-data and determine if students were completing Typing Agent activities. In spite of the lack of instructional time spent on typing, the teachers did express that the intervention appeared to be beneficial, as some students had transitioned from using one hand to typing with both hands and using the home keys. For students with little experience keyboarding, even a small amount of practice may be beneficial. Average scores increased in both typing speed and accuracy for both the treatment and control groups, which could reflect a practice effect. Students in both conditions used Typing Agent during the pre-assessment,

and some students in the control group continued to use it during the intervention because they had access to the software through the school's cloud-based portal. The presence of a practice effect may have made it more difficult to observe differences between groups.

The intervention was intended to give teachers training in how to use and manage Typing Agent software, but there was not enough time during check-ins to ensure that teachers were proficient in these skills. This suggests that interventions using any typing software should devote sufficient time to train teachers in the software. This training is an essential component to ensure the teacher can overcome technical difficulties and manage students as they use the software in their daily practices.

Student experiences (RQ5).

Students reported generally positive experiences using computers for writing instruction and described using a computer for writing as a novel experience that was connected to their learning at school. Similar themes emerged across both focus groups, suggesting that student experiences were similar in spite of differences in implementation between school sites. Both teachers observed that students were typing more by the end of the intervention than at the beginning, indicating that students had experienced some benefit from participating in the intervention. The findings related to these positive experiences suggest that, when using digital tools for writing, teachers should integrate these activities into the current curriculum. Doing so will allow students to make connections between their experiences with the digital tool and their content learning during literacy classes and see the benefit of using the computer on their academic success.

Another positive trend was that students indicated a preference for typing over handwriting. This preference may have been related to the novelty of using computers for the students in this study. Schools should consider students' preferences for writing expression when implementing computer-based writing instruction. Considering these preferences when planning for an intervention may allow educators to tailor the research design to ensure that students' experiences are positive. The primarily positive experiences of students in the present intervention may have contributed to the positive results for writing achievement.

Teachers and students also described technical difficulties as negatively impacting student experiences, which highlights the importance of establishing routines and systems to overcome technical challenges. During focus groups, students also described physical discomfort when using computers for instruction. This suggests that an intervention that integrates computer-based tools should consider adequate dosage that does not result in extended computer usage and physical discomfort.

Limitations.

There were a number of limitations to the study that resulted from the research design, practical considerations, and obstacles that arose during implementation. These limitations included a potential practice effect, differences in research sites, and limited generalizability of the findings based on the small sample size. When engaging in the pre-assessment, both the treatment and control conditions were exposed to both Google docs and Typing Agent. Exposure to these intervention components may have led to practice effect and/or contamination. Specifically, some students in the control condition continued using Typing Agent after learning how to access it during the pre-assessment.

Another limitation of this study was the differences between the two research sites. Teacher one was a librarian who expressed discomfort with technology and classroom management, while teacher two was the writing teacher who had previously used Google docs and expressed comfort with using the tool during writing activities. Additionally, the intervention took place in different settings during different times of the day across two different grade levels (fourth and fifth). They also took place over different lengths of time (library was 60 minutes and literacy class was 90 minutes). Despite these differences, a significant treatment effect for writing achievement was found overall, and this effect was not different between school sites. This suggests that while these differences may not have impacted the conclusions, they demonstrate ways in which the research protocol was not standardized across sites.

The findings of the present study are further limited by issues arising from fidelity of implementation. Typing Agent instruction was not implemented as planned. Students did not have as much weekly class time to use Typing Agent as specified in the research protocol, and their typing time consisted primarily of unstructured practice rather than explicit typing instruction. Both teachers prioritized writing instruction using Google docs over Typing Agent. My inability to obtain Typing Agent metadata made it difficult to assess the extent to which students used the software. An additional limitation resulting from intervention implementation was the lack of Google comments feedback provided by teachers. This feedback was included in the research protocol as a useful feature of cloud-based writing based on the findings from the intervention literature review in chapter three. While teachers and students did not use the collaborative features of Google docs, a positive impact on writing achievement after using a digital tool for

writing was found. This suggests that there were positive impacts of using a digital tool during writing instruction even without the collaborative features.

The intervention findings were also limited by the variation in student effort during the assessments, which made it difficult to differentiate between effort and ability. Several students received scores of zero for writing and typing on the pre-assessment. In some cases this score may have reflected student ability, such as an incorrect and/or incomplete response, while in other cases the zero may have reflected a lack of student effort. The presence of a floor effect, particularly the low average scores (below one out of four) on the writing pre-assessment, limits the generalizability of the findings. The results might have been different in a sample with a higher level of baseline performance.

Implications for future research and practice.

The present study explored the impact of incorporating digital tools into writing instruction. To extend these findings and enable them to benefit education practitioners, future research can address some of the limitations of the present study. Using random assignment and drawing from a larger sample from a single research site would enable researchers to better standardize the implementation of the intervention. Future research could also delve deeper into isolating specific digital skills, such as keyboarding skill or ease navigating a passage, from the broader skill of writing. An intervention that focuses on one particular skill rather than simultaneously adding writing and typing instruction may produce a greater impact on that skill. Using measures that include specific digital skills, such as the number of characters typed, would also provide a way to determine whether an intervention is beneficial to student digital literacy or to writing ability.

Teacher preparation and adherence to the prescribed protocol were identified as important considerations for future research in this area. The present study reported differences between teachers in their classroom practices, comfort level when teaching with digital technology, and classroom management skills. To prepare to implement computer-based writing instructions, teachers may benefit from explicit instruction on and personal experience with the specific digital tools being used. Both teachers in this intervention expressed that their participation in the intervention increased their comfort level using digital technology, but only one teacher felt prepared to continue these practices in the future.

Teacher preparation could also include instruction on preparing lessons and materials specifically designed for use in a digital environment, such as using SMART boards for demonstration. Future research can address these obstacles by providing additional teacher training prior to the intervention to create a sustainable model of digital writing instruction. This training should ensure that teachers feel comfortable using the digital tools, provide teachers support with scripting routines and procedures to help with classroom management during technology use, and introduce ways to navigate technical difficulties that could arise. Building in time and problem-solving experience in this area would assist in intervention implementation and may increase teacher buy-in.

Conclusion

Educators have the opportunity to provide students with digitally-based writing experiences, which can help them develop digital writing skills in an academic context. In many places, including Washington, DC, schools may have access to the necessary digital technology, but these resources may be underutilized. Engaging in six weeks of

digitally-based writing lessons led to significantly greater growth in student writing achievement scores compared to typical writing instruction. While there were not significant differences between groups in typing skill, this may have resulted from a lack of fidelity of implementation in using Typing Agent software at both schools.

Obstacles arose throughout the intervention, including changing school schedules, differing levels of teacher comfort using technology in the classroom, the need to promote student engagement in classroom tasks, and the need to structure lessons that sufficiently include all of the planned content. Additional obstacles arose while ensuring there were enough available computers for intervention lessons and accessing Typing Agent metadata.

In spite of obstacles to implementation, and by learning from them, the intervention described in this paper provides insight into the benefits of integrating computers into writing instruction. After providing students with opportunities to use Google docs for drafting and revising writing one day per week and introducing keyboarding, there was a positive impact on writing achievement outcomes. These findings suggest that educators have the opportunity to support student writing achievement by integrating computer-based writing opportunities into the writing curriculum.

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Appendix A

Teacher Experiences Interview Questions

RQ1

- Describe students' use of Google docs this week. Describe students' use of Typing Agent this week.
- How aligned have you been to the scope and sequence created during the initial coaching check-in?
- What adjustments did you make this week? Why?
- What problems, if any, did you encounter? What supports might you need?
- What did you like and dislike about this process?

RQ2

- How did students do this week during the intervention? What trends did you see?
- Were students engaged in Google docs/Typing Agent? Why or why not?

RQ3

- Did you grade any writing tasks this week? If so, what trends did you see?
- What impact, if any, has the use of Google docs and Typing Agent had on writing outcomes this week?

RQ4

- What have you observed about students' keyboarding skills this week while they have been using Typing Agent?

RQ5

- What have you observed about students experiences with computer-based writing?

Appendix B

Experiences and Perceptions Focus Group Questions

What did you think of using computers in writing class this semester?

What kinds of things did you do with the computers in writing class?

What did you like best about using computers?

What did you like the least?

How do you feel about writing with computers?

Appendix C

Research Plan

Research Plan: Promoting Equity in Computer-Based Writing

Table of Contents

Intervention Calendar

Week	Monday	Tuesday	Wednesday	Thursday	Friday
PRE INTERVENTION	1 (NO SCHOOL)	2 (NO SCHOOL)	2 School 2 Check-In: 8:45-9:30	3	4 School 1 Check-In: 2:30-3:15
1 (JAN 7)	7 Pre-Assessments	8 School 1 Check-In: 8-8:45	9 Lesson 1 (2A) School 2 Check-In: 8:45-9:30	10	11 Lesson 1 (1A)
2 (JAN 14)	14	15 School 1 Check-In: 8-8:45	16 Lesson 2 (2A) School 2 Check-In: 8:45-9:30	17	18 Lesson 2 (1A)
3 (JAN 21)	21 (NO SCHOOL)	22 PD DAY	12 PD DAY	24 School 2 Check-In: 8-8:45	25 Lesson 3 (1A) School 1 Check-In: 11-11:45AM
4 (JAN 28)	28 Lesson 3(2A)	29 School 2 Check-In: 12-12:45	30 Lesson 4 (2A)	31	1 Lesson 4 (1A) School 1 Check-In: 11-11:45AM
5 (FEB 4)	4	5 School 2 Check-In: 12-12:45	6 Lesson 5(2A) Check-In: 8:45-9:30	7	8 Lesson 5 (1A)
6 (FEB 11)	11	12 School 1 Check-In: 12-12:45	13 Lesson 6 (2A) School 2Check-In: 8:45-9:30	14 Lesson 6 (A)	15 Mid-Assessment

Lesson Objectives, Texts, & Assessment Prompts:

Pre- Assessment: You have read a passage from "The Wild Horses of Assateague Island," "Wild Ponies of Chincoteague," and "In Thunder and Rain, Chincoteague Ponies Make Annual Swim." Think about the illustrations from the passages and how they help the reader learn more about the ponies. Write an essay explaining what can be learned from the illustrations about the lives of the ponies described in the passages. Include details from all three sources in your explanation.

Text 1, Group 1: A Nation Divided & Video:

https://www.youtube.com/watch?v=nsP_Uqk-uQw&pbjreload=10

Prompt: You have read "A National Divided" and watched a video about the causes of the Civil War. The division within the United States greatly affected the nation. Based on the information from the video and the text, think about why the nation was divided and how this division affected the United States. Write an essay about the causes of the Civil War. Include details from both the text and video in your essay.

1. SWBAT identify keyboard keys needed for computer-based writing by considering writing conventions (punctuation, indentation, capitalization).
2. SWBAT plan and draft a computer-based essay by using the prompt to identify relevant quotations.
3. SWBAT draft and revise a computer-based essay by using sentence stems to elaborate on evidence.

Text 2, Group 1: The Two Harriets: Heroines of the Civil War & Video:

https://www.youtube.com/watch?v=CkF67SMrBUE

Prompt: You have read and watched a video about the life of two heroines who made a significant impact on the nation during the Civil War. Think about the impact of Harriet Tubman and Harriet Beecher Stowe on the Civil War and the end of slavery in the United States. Write an essay about Harriet Tubman and Harriet Beecher Stowe and their impact on the end of slavery. Use details from the text and the video in your response.

4. SWBAT plan and draft a computer-based essay by explaining the connection between the evidence and thesis statement.
5. SWBAT draft and revise a computer-based essay by adding relevant transition words.
6. SWBAT evaluate a computer-based essay by leaving Google comments aligned to the PARCC LAT rubric.

Post-Assessment: Video:

https://www.youtube.com/watch?v=_rPciAu392k&pbjreload=10

You have read the passage from Owen & Mzee: The language of Friendship, which describes how a hippo and a tortoise depend on one another. You have also viewed a video about the connection between mongooses and hornbills. Think about how these relationships are different. Write an essay that describes how the friendship between Owen and Mzee is different from the relationships between mongooses and hornbills. Use examples from both the article and the video to support your conclusions.

Lesson 1:

Standard	CCSS.ELA-LITERACY.W.4.6 With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting. CCSS.ELA-LITERACY.W.5.6 With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of two pages in a single sitting.
Objective	SWBAT identify keyboard keys needed for computer-based writing by considering writing conventions (punctuation, indentation, capitalization).
Materials	Student handout; anchor chart, projector & computer, nonfiction text
Pre-Work	None
Introduction	Why: *The other day, I got a text from one of my friends. While reading it, I had NO idea of what it meant. There were no capitalized letters or punctuation, so I did not know where one idea ended and another began. This made me realize that whenever we type a message, it is important to make sure that the information is correct before we send it so that other people understand our message. This is very important when using computers for writing.* What: *Today, we are going to learn how to type information correctly so that other people can understand our message.* How: *We are going to do this by identifying important writing conventions in a book and connecting it to a keyboard. After we do this, we are going to practice using these keyboard commands on Typing Agent.*
Model	*Watch me do this first. First, I am going to look at this text. One thing I notice about this text is that there is a space before each paragraph. With a silent hand, what do we call these spaces before each paragraph?* (indent) *At the beginning of a paragraph we need to indent. Now that I notice this, I need to figure out how to indent on the keyboard. At the end of a paragraph a need to go down first. So I need to press "enter". After I press enter, I need to press "tab" to create the indentation. Finally, I write on the chart that to start a new paragraph with indenting I need to press "enter" and then "tab" on the keyboard. When I say go, you have 30 seconds in a whisper voice to tell your partner how to indent paragraphs when you are typing. Go.* (debrief turn and talk) *Let's all add this to our notes on our handout.*
Guided Practice	*With a silent hand, what are other writing conventions we should add to our anchor chart other than indenting?* (call on students and add to anchor chart; continue to call on students until you have capitalization, punctuation, quotation marks, and apostrophes). *How do we use the keyboard to ____?* (repeat this question for each of the conventions; include students in naming the steps; prompt students to add the information on the anchor chart to their handout.

Independent Practice	Students will transition to typing agent to practice the keyboarding writing conventions. The teacher will circulate the room and support students on using the keyboard to type correctly.
Closing	*Today we learned how to type correctly using the keyboard. Why is it important to type our writing correctly?* (so that others understand our message) *What is something new you learned that you will use every day you write with a computer?*

Name: _____

Lesson 1: Student Handout

Typing with the Keyboard: Writing Conventions

Convention	How to Use the Keyboard
Indenting Paragraphs	
Comma	
Punctuation	
Quotation marks	
Erase/delete	
Others?	

Lesson 2:

Standard	CCSS.ELA-LITERACY.W.4.4 & CCSS.ELA-LITERACY.W.5.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.
Objective	SWBAT plan and draft a computer-based essay by using the prompt to identify relevant quotations.
Materials	Anchor chart; student handout; student text (A Nation Divided); video
Student Pre-Work	Read student text (A Nation Divided) and watch video (linked above)
Introduction	***Why****: Whenever I sit down to write a lesson plan, an essay for a text, or a paper for college, I get "writers' block". "Writers' block" is that feeling when you have no idea where to start your writing. Raise a silent hand if you have heard of "writers' block".* (teacher acknowledges students who raise their hand) *One way to avoid feeling the anxiety of "writers block" is to become an expert planner*. **What**: *Today, we will learn how to plan our essay using the boxes and bullets organization system.* **How**: First, draw a box and bullets. Second, echo the question and write in the box. Third, find one quotation from each source and write as bullets. Last, answer the question in the box by considering the evidence you selected.
Model & **Guided Practice**	*Right now, we are writing essays on the following prompt.* (take student volunteer to read the prompt). "You have read 'A Nation Divided' and watched a video about causes of the Civil War. The division within the United States greatly affected the nation. Based on the information from the video and the text, think about why the nation was divided and how this division affected the United States. Write an essay about the causes of the Civil War. Include details from both the text and video in your essay. *First, I draw my box and bullets. Second I need to flip or echo the question. Let's go to the prompt and underline the questions we notice. For example, I see "why was the nation divided". Let's underline that.* ***Silently think about the other questions you see. When I say go, you have one minute to share the questions you underlined with a partner. Hint: there are two more questions. Go. Why did you underline "how this division affect the US"?*** **(wait 3 seconds and then call on student who underlined that fact).** ***Great! "Why did you underline "cause of the Civil War"?*** (wait 3 seconds then call on student; if no student underlines this, point out that this phrase asks for the causes*). This means I have three stems I can echo and write in the box. If I echo or flip "why was the nation divided" I would write my essay would begin "The nation was divided because…" "Let's write that together. Now, we only need one question to start off the essay, so we are down with the first step. However, let's think about the other two questions we underlined.* ***How else could my essay begin? When I say go, echo the other two questions we noticed. Exactly, our essay could have begun "The division affected the US because…" or "Causes of the Civil War include…".***

	The second step is to pull evidence to use as our bullets. Watch as I pull a quotation that connects to my echoed question. My essay starts with "The nation was divided because…". Now, I underline a reason in the text and copy it directly as a bullet with quotation marks. Write with me now. (Students write while teachers pulls up the video). ***Now it is your turn. I am going to play the video. As I play the video, look for evidence from the video to finish the starter "The nation was divided because…" Write it as a bullet when you hear your evidence. What will you do during the video?*** **(write my evidence as a bullet).**
Independent Practice	Now that we have our evidence. How would you finish our echo in the box? (wait, then call on student and write response. When we transition to the lab, you are going to open the document in your folder labeled "Causes". Once you open it, start typing the information from your plan as a draft. When you finish and the teacher checks your draft, you can transition to Typing Agent.
Closing	*Today, we learned how to plan an essay using boxes and bullets. We then began drafting our plan. What are the steps to making a plan?* (draw box and bullets, echo the question in box, pull evidence in bullets, answer the question in the box). *How is planning helpful?*

Name: _____

Lesson 2: Student Handout

Plan Essay Using Boxes and Bullets

How:

1) Draw box and bullets
2) Echo the question and write in the box
3) Pull evidence from both sources and write as bullets
4) Answer the question and write in the box

Let's try it together!

Take notes here:

Lesson 3:

Standard	CCSS.ELA-LITERACY.W.4.6 With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting. CCSS.ELA-LITERACY.W.5.6 With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of two pages in a single sitting.
Objective	SWBAT draft and revise a computer-based essay by using sentence stems to elaborate on evidence.
Materials	Sentence stem anchor chart; Computer, google doc with draft of first two paragraphs,
Student Pre-Work	Students will need to have read the text, watched the video, and completed the plan.
Introduction	Why: *Yesterday, we learned how to plan an essay. With a silent hand, what tool can we use to plan? (*box & bullets*). Yes! Why is planning this way helpful to writers? (*it helps prevent writers block & it makes your essay organized*). When we draft, it is important that we do it quickly. This means, that we make mistakes, which is okay! That is why we also revise our writing, or make it better. What does it mean to revise? (*to improve writing). What: *Today, we are learning to revise or improve our writing by re-reading it.* *How: 1) finish drafting 2) find a place to elaborate or say more 3) pick a sentence stem 4) add your sentence 5) repeat until each detail paragraph is at least 3-5 sentences*
Model	*My first step is to finish my draft. Watch as I think aloud how to finish the draft. Listen for questions I ask myself as I draft* (teacher drafts paragraphs 3 and 4 in two minutes or less; questions include "what is my main idea?", "what is my evidence?", "what is my conclusion?"). *What questions did I ask myself as I drafted?* (teacher calls on three students to share). *Now that I have completed step one, I can move to step 2. When I say go, silently read my first detail paragraph, which is paragraph 2. As you read, think: Where should we elaborate or say more? When you have an idea of a place to revise by elaborating, raise a silent hand.* (student identifies a place to revise and teacher models picking a sentence stem, and adding a detail).
Guided Practice	*We just revised my draft using our steps. Step 5 is the most important step. We need to repeat this process until our ideas are fully developed. Where is another place where I could elaborate using a sentence stem? Which sentence stem should I use here? How should I finish this sentence?* (teacher repeats with students until one or both detail paragraphs are fully developed)

Independent Practice	*When we transition to the lab, you are going to open the document in your folder labeled "Causes". Once you open it, start with step 1, which is to finish your draft. When your draft is finished, move on to the next steps and revise your writing by using sentence stems to elaborate. I will be walking around to help you find places to add ideas. Once each detail paragraph is 3-5 sentences, you can begin working on Typing Agent.*
Closing	*Today, we drafted and revised our essays by using sentence stems. How do you revise?* (finish your draft and use sentence stems to elaborate or say more) *Why do we always draft before revising?* (We need to have our main ideas and evidence written before we can add ideas during revision)

Name: _____

Lesson 3: Student Handout

Draft and Revise Using Sentence Stems

How?

1) finish drafting
2) find a place to elaborate or say more
3) pick a sentence stem
4) add your sentence
5) repeat until each detail paragraph is at least 3-5 sentences

Sentence Stems

Introduction Paragraph Sentence Stems:

- This essay is about…
- This paper will discuss…
- This essay will explore…

Detail Paragraph Sentence Stems:

- One reason why…
- Another reason for…
- Evidence to support this idea includes…
- Evidence that supports the idea that ____ includes…
- The text ____ states, "_____".
- This evidence means…
- This evidence shows that…
- This evidence demonstrates…

Conclusion Paragraph Sentence Stems:

- The evidence presented in this essay shows…
- One can conclude ____ based on the evidence in this paper.

Lesson 4:

Standard	CCSS.ELA-LITERACY.W.4.4 & CCSS.ELA-LITERACY.W.5.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.
Objective	SWBAT plan and draft a computer-based essay by explaining the connection between the evidence and thesis statement.
Materials	Anchor chart; student handout; student text (The Two Harriets: Heroines of the Civil War); video
Student Pre-Work	Read student text (The Two Harriets: Heroines of the Civil War) and watch video (linked above)
Introduction	***Why****: During our last essay, you all did such a great job planning! Those plans created amazing four paragraph essays with evidence. With a silent hand, remind me the tool we can use to plan essays.* (boxes and bullets) *Why do we use this tool?* (prevent writers' block anxiety and be organized writers). **What**: *Today, we will plan and draft our essays by considering connections between the thesis and evidence.* **How**: Create your plan. Begin drafting. After the evidence, finish the starter "This evidence shows (the answer or thesis) because…".
Model & **Guided Practice**	*Right now, we are writing essays on the following prompt.* (take student volunteer to read the prompt). You have read and watched a video about the life of two heroines who made a significant impact on the nation during the Civil War. Think about the impact of Harriet Tubman and Harriet Beecher Stowe on the Civil War and the end of slavery in the United States. Write an essay about Harriet Tubman and Harriet Beecher Stowe and their impact on the end of slavery. Use details from the text and the video in your response. *What are the steps to planning? As we list them, write the steps silently on your handout.* (Draw box and bullets, Echo the question and write in the box, Pull evidence from both sources and write as bullets, Answer the question and write in the box). *When I say go, you and a partner will have 2 minutes to begin these steps. After two minutes, we will finish the plan together. Go.* (Teacher and students finish the plan.) *Now that we have our plan, I am going to type the thesis statement, or sentence in the box, as my first paragraph. Now that I am on my second paragraph, I am going to write the reason and evidence just like we did last time. Then I am going to add a step to our drafting by using the sentence stem* "This evidence shows (the answer or thesis) because…". *As you watch me do this, consider how we will use the same strategy to draft the second detail paragraph.* (Teacher models the reason, evidence, explain drafting process for a detail paragraph.)
Independent Practice	*Today as you draft, make sure each detail paragraph includes a reason, evidence, and explanation. What can you use as you draft? Why is it important that each detail paragraph has evidence?* When we transition to the lab, you are going to open the document in your folder labeled "Harriets". Once you open it, start typing the information from your plan as a draft by explaining the connection between your evidence and thesis. When you finish and the teacher checks your draft, you can transition to Typing Agent.

Closing	*Today, we learned how to explain our evidence by connecting it to the thesis. How do you explain evidence? Why do good writers always explain evidence?*

Name: _____

Lesson 4: Student Handout

Plan Essay Using Boxes and Bullets

How?

1) _____
2) _____
3) _____
4) _____

Plan!

Drafting detail paragraphs (reason, evidence, explain: “This evidence shows (the answer or thesis) because…”.)

Lesson 5:

Standard	CCSS.ELA-LITERACY.W.4.2.C Link ideas within categories of information using words and phrases (e.g., *another*, *for example*, *also*, *because*). CCSS.ELA-LITERACY.W.5.2.C Link ideas within and across categories of information using words, phrases, and clauses (e.g., *in contrast*, *especially*).
Objective	SWBAT draft and revise a computer-based essay by adding relevant transition words.
Materials	Teacher-generated draft; anchor chart; student handout; student text (The Two Harriets: Heroines of the Civil War); video
Student Pre-Work	Read student text (The Two Harriets: Heroines of the Civil War) and watch video (linked above)
Introduction	***Why***: *Last night, I was reading a magazine called The New Yorker. As I was reading, everything flowed together almost like a dance. I really enjoyed reading it because the flow made me read faster and made the information more interesting. I noticed that the author used transition words to create this flow.* **What**: *Today, we will revise our essays by adding transition words and phrases at the beginning of sentences.* **How**: First, finish drafting. Second, find a place to add a transition word. Third, pick a relevant or appropriate transition word and add it to the beginning of the sentence. (Don't forget the comma!)
Model	*My first step is to finish my draft, which you can see on the board. Now that I have completed step one, I can move to step 2. Watch as a think aloud how I would add a transition word to my first detail paragraph. As you watch me think aloud, ask yourself "how will I add transition words to my writing?" What will you think while I model?* (Teacher adds "for example" before stating evidence. During think aloud, the teacher discusses the pros and cons of using a transition at the beginning of a paragraph). *How will you add transition words to your writing?* (read the draft, find a place, consider the best transition word or phrase, add it and don't forget the comma!)
Guided Practice	*Now, I need your help adding more transition words. When I say go, you and a partner will have 2 minutes in a whisper voice to add as many transition words to my draft as you can. Make sure the transition word makes sense. Also, what do you need to remember to include?* (the comma) *Go.* Students turn and talk. After the turn and talk, the teacher calls on 3-5 students and thinks aloud the keyboard keys needed to add the transition to the draft.
Independent Practice	*Why is it important to use transition words? How do you add transition words? What should you remember when you add transition words? When we transition to the lab, you are going to open the document in your folder labeled "Harriets". Once you open it, start with step 1, which is to finish your draft. When your draft is finished, move on to the next steps and revise your writing by adding transition words and phrases. I will be walking around to support your revising. Once you finish adding transitions, you can begin working on Typing Agent.*

Closing	*Today, we drafted and revised our essays by adding transition words. How do you revise?* (finish your draft and use sentence stems to elaborate or say more OR add transition words) *Why do we always draft before revising?* (We need to have our main ideas and evidence written before we can add ideas during revision OR add a relevant transition)

Name: _____

Lesson 5: Student Handout

Revise by Adding Transition Words and Phrases

How?

- First, finish drafting.
- Second, find a place to add a transition word.
- Third, pick a relevant or appropriate transition word and add it to the beginning of the sentence. (Don't forget the comma!)

Transition Words and Phrases

Add Information:

- For example,
- Also,
- Furthermore,
- Additionally,
- Moreover,
- In addition,
- For this reason,
- In fact,
- For instance,

Compare & Contrast:

- Similarly,
- In comparison,
- In contrast,
- However,
- On the other hand,
- Conversely,

Conclude:

- In conclusion,
- In summary,
- In short,

Lesson 6:

Standard	CCSS.ELA-LITERACY.W.4.6 With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting. CCSS.ELA-LITERACY.W.5.6 With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of two pages in a single sitting.
Objective	SWBAT evaluate a computer-based essay by leaving Google comments aligned to the PARCC LAT rubric
Materials	Teacher-generated final draft; PARCC LAT rubric as student handout; text (The Two Harriets: Heroines of the Civil War); video
Pre-Work	Students must have planned, drafted, and revised their essay.
Introduction	**Why***: Technology is pretty incredible. Take emails and texting. Before computer and phone technology, you had to actually send hand written messages to other people around the world. This meant a simple message could take weeks before it was communicated. With technology, we can communicate with a click of a button!* **What:** *Today, we are going to give feedback to one another by using the assignment rubric to give "glows" and "grows" as Google comments.* **How:** 1) select and read a peer's essay 2) use the rubric to give feedback ("glow" and a "grow") 3) type and send your feedback as a comment
Model	*Before we can leave feedback as Google comments, we need to understand the rubric. We are going to reach the first column of the rubric together and underline what we can use as "glows" and "grows".* (Teacher reads and underlines some feedback. Teacher also asks "What can I underline and use as feedback?"). *Now that I know the rubric, I can start my steps. First, I am going to go to the class folder and pick a student. The peer does not matter because we will get a chance to leave comments for more than one friend. As I read the essay, your job is to think about something the student does well, or the glow, and one thing they can do better, or the grow. What will you do as I read the essay?* *I have read the essay and am ready to leave my comment. To do this, I go to the top right hand corner and select "comment". Now, I type the comment using "I like how…" for the glow and "Next time try…" for the grow.* (Teacher types the comment). *It is important to remember to submit your comment by clicking this blue button. How do you submit the comment after you type it?*

Guided Practice	*Now, let's try another one. What do I do first? How? What do I do next? How? When I say go, turn and talk with a partner to decide on your feedback for this essay. You have 1 minute. Go.* (teacher types comment)
Independent Practice	*When we transition to the lab, you are going to open the class folder and select a peer to give feedback. Use the rubric to give a glow and a grow to three of your peers. Once you finish adding comments for three friends, you can begin working on Typing Agent.*
Closing	*Today, we used technology to give each other feedback on our writing by leaving Google comments. How do you leave good feedback? Why is it helpful to use technology to give feedback, especially for writing?*

Biographical Statement

Deanna Santoro was born in New York City. While she lived in multiple places along the east coast throughout her childhood, she primarily grew up in South Carolina and New York. In college, she studied Political Science at the University of North Carolina at Chapel Hill. After college, she served as a 2011 Teach for America Corps member at a Mastery Charter elementary school in West Philadelphia. During this time, she also attended the University of Pennsylvania. In 2013, she completed her corps years and graduated with a Master of Science in Urban Education. After graduation, she moved to Washington, DC to teach elementary literacy and work as an instructional coach. Currently, she works as an Assistant Professor of Practice for a graduate school of education in DC. Through this work, she helps to train novice teachers in a residency program that partners with schools in DC to create a pipeline of well-prepared teachers. She has been working towards this doctoral degree since 2015.